TECHNICAL MANUAL

ANTI-ICING, DEICING, AND DEFROSTING OF PARKED AIRCRAFT

WARNING: This T.O. is incomplete without reference to the Air Force Standards Agency's (AFFSA/XO) Holdover Tables. See Paragraph 7.3.1.1, Step a. Users who rely on printed copies must reproduce and file a copy of the current Holdover Tables with this T.O.

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INTRODUCTION

1. PURPOSE.

The purpose of this document is to provide instructions for the removal of frozen precipitation (deicing) and the prevention of frozen precipitation formation (anti-icing) from parked aircraft. The fluids identified in this document for anti-icing are applicable only to fixed wing aircraft.

2. SCOPE.

This document is applicable to all organizations using deicing/anti-icing fluids on aircraft. This document has adopted much of the Federal Aviation Administration (FAA) ground deicing program guidance as standard Air Force practice.

3. APPLICABLE DOCUMENTS.

The documents listed in Paragraph 3.1 and Paragraph 3.2 below are specified in Chapter 1 through Chapter 7 of this document. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Chapter 1 through Chapter 7 of the document, if they are listed.

3.1 Government Documents. The following specifications, standards, and T.O.s form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are listed in the Department of Defense Index of Specifications and Standards (DODISS).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-A-8243	Anti-Icing and Deicing – Defrosting Fluids

STANDARDS

AIR FORCE OCCUPATIONAL SAFETY AND HEALTH (AFOSH)

AFOSH STD 91-501	Air Force Consolidated Occupational Standards
AFOSH STD 91-100	Aircraft Flight Line – Ground Operations and Activities

TECHNICAL ORDERS

T.O. 35E17-12-1	Spraying Unit, Hot Air Blast, for Use TM-1800 Truck Mounted Aircraft Deicer
T.O. 35E17-6-11	Spraying Unit, Cleaning, Deicing, Decontaminating Fluid, Truck Mounted
T.O. 35E17-6-21	TM-1800 Truck Mounted Deicer/ Washer 621-2150
T.O. 42C-1-12	Quality Control of Chemicals

FEDERAL AVIATION ADMINISTRATION (FAA)

AC 20-117	Hazards Following Ground Deicing and Ground Operations in Conditions to Aircraft Deicing
AC 120-58	Pilot Guide for Large Aircraft Ground Deicing
AC 135-17	Pilot Guide for Small Aircraft Ground Deicing
AC 120-60	Ground Deicing and Anti-icing Program
AC 135-16	Ground Deicing and Anti-icing Training and Checking

(Applications for copies should be addressed to the U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Ave, Landover, MD 20785.)

REGULATIONS

AFI 11-202 Vol. 3	General Flight Rules
AFI 32-1002	Snow and Ice Control

3.2 Non-Government Publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents that are Department of Defense (DoD)-adopted are those listed in the issue of the DODISS. Unless otherwise specified, the issues of documents not listed in the DODISS are the current issues of the documents cited in this technical manual.

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS 1424	Deicing/Anti-Icing Fluid, Aircraft, SAE Type I
AMS 1428	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian, (Pseudoplastic), SAE Types II, III, and IV
ARP 1971	Aircraft Deicing Vehicle-Self Propelled, Large Capacity

ARP 4737	Aircraft Deicing/Anti-Icing Methods with Fluids
ARP 5149	Training Requirements for Deicing/Anti-Icing of Aircraft on the Ground (Draft)

(DoD activities may obtain copies of these standards from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

4. ABBREVIATIONS/ACRONYMS.

The abbreviations/acronyms used in this document are defined as follows:

AC	Advisory Circular
AEA	Association of European Airlines
AFCESA	Air Force Civil Engineering Agency
AFI	Air Force Instruction
AFFSA	Air Force Flight Standards Agency
AFOSH	Air Force Occupational Safety and Health
AIA	Aerospace Industries Association
AMS	Aerospace Material Specification
APU	Auxiliary Power Unit
ARP	Aerospace Recommended Practices
AST	Aircraft Skin Temperature
BMP	Best Management Practice
DC	Direct Current
DoD	Department of Defense
DODISS	Department of Defense Index of Specifications and Standards
ELOUT	Estimated Lowest Operational Use Temperature
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FSAT	Flight Standards Information Bulletins for Air Transportation
HABS	Hot Air Blast System
ISO	International Standards Organizations
L	Local
LOUT	Lowest Operational Use Temperature
LOX	Liquid Oxygen
MAJCOM	Major Air Command
MSDS	Material Safety Data Sheet
NEAT	Fluid that is not diluted, supplied as a concentrate
NPDES	National Pollutant Discharge Elimination System
OAT	Outside Air Temperature
OPR	Office of Primary Responsibility
OSHA	Occupational Safety and Health Administration
ppm	parts per million
Premix	Mixture of fluid and water accomplished by supplier or at the storage tank during loading
Propmix	Mixing of fluid and water at a proportional mixing valve just prior to the spray nozzle
SAE	Society of Automotive Engineers
S&ICP	Snow & Ice Control Plan
S&ICC	Snow & Ice Control Committee
SOF	Supervisor of Flying
SWPPP	Storm Water Pollution Prevention Plans

SAFETY SUMMARY

1. GENERAL SAFETY INSTRUCTIONS.

This document describes physical and chemical processes which may cause injury or death to personnel, or damage to equipment if not properly followed. This safety summary includes general safety precautions and instructions that must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment. Prior to performing any task, the WARNINGs, CAUTIONs, and NOTEs included in that task shall be reviewed and understood.

2. WARNINGS, CAUTIONS, AND NOTES.

WARNINGs and CAUTIONs are strategically placed throughout this manual to highlight operating or maintenance procedures, practices, conditions, or statements which are considered essential to protection of personnel (WARNING) or equipment (CAUTION). WARNINGs and CAUTIONs are placed immediately preceding the step or procedure to which they apply. WARNINGs and CAUTIONs consists of four parts: heading (WARNING, CAUTION, or icon [See Paragraph 3.]), a statement of the hazard, minimum precautions, and possible result if disre garded. NOTEs are used in this technical manual to high light operating or maintenance procedures, practices, condi tions, or statements which are not essential to protection of personnel or equipment. NOTEs may precede or follow the step or procedure, depending upon the information to be highlighted. The headings used and their definitions are as follows:

WARNING

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in long-term health hazards, injury to, or death of personnel.

CAUTION

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement.

3. HAZARDOUS MATERIALS WARNINGS.

Hazardous Materials WARNINGs in the document are provided through use of the Hazard Symbols listed below. Reference Paragraph 3.2 below or Material Safety Data Sheets (MSDS) (Occupational Safety and Health Adminis tration (OSHA) Form 174 or equivalent) for specific infor mation on hazards, effects, and protective equipment requirements. If you do not have an MSDS for the material involved or have questions concerning content, contact your supervisor, Base Safety or Bio-Environmental Engi neering Offices.

3.1 Hazardous Materials Icons. Icons are used in this manual to identify dangers associated with hazardous materials. The icons used and their definitions are as follows:

The symbol of drops of liquid onto a hand shows that the material will cause burns or irritation of skin and tissue.

The symbol of a person wearing goggles shows that the material will injure eyes.

The symbol of a flame shows that the material can ignite and burn.

3.2 Hazardous Materials Description. The following hazardous material is used in this technical manual. Ensure authorization for use and be aware of and follow required safety practices. Each icon represents certain hazards as described above in Paragraph 3.1. Beneath the icons is the hazardous material name and a reference number. Below the icons, material name, and reference number is a description of the hazardous material. Only the icons, material name, and reference number are used in the text of the manual. If a full description of the hazardous material is required while performing procedures in this document, use the reference number to locate the appropriate description below.

Anti-Icing, Deicing, and Defrosting Fluids, MIL-A-8243	1
Deicing/Anti-Icing Fluid, Aircraft, AMS 1424, Type I	2
Fluid, Aircraft Deicing/Anti-Icing, Non-newtonian (Pseudoplastic), AMS 1428, Types II and IV	3

Anti-icing, deicing, and defrosting fluids, MIL-A-8243, Type I/II, AMS 1424, Type I, AMS 1428, Type II/IV, are mildly toxic and contact with skin or eyes should be avoided. Prolonged exposure to concentrations exceeding 1000 parts per million parts of cubic volume of air should be avoided. The fluids may possibly flash at temperatures above 200°F and proper precautions should be taken to insure that the fluids are kept away from all sparks, fire, and oxidizing agents. Adequate eye protective equipment shall be worn by all personnel engaged in the application of these fluids.

4. SAFETY PRECAUTIONS.

The following safety precautions shall be observed while performing procedures in this manual.

- Deicing fluids containing ethylene glycol (MIL-A-8243, Type II) have been found to cause severe spalling of portland cement concrete pavements. This damage may be prevented or minimized by treating such pavements prior to exposure with light seal coats of emulsified linseed oil.
- Asphalt pavements do not require protective coatings and linseed oil will not be applied to these pavements.
- The presence of either deicing or anti-icing fluids around Liquid Oxygen (LOX) servicing/overflow areas can result in a potential fire.
- Prior to LOX servicing, the fluids shall be removed from areas adjacent to the LOX filter and overflow tubes by flushing or wiping methods. Contact of fluid with LOX, a powerful oxidizing agent may result in a fire or explosion.
- Remove fluid from around LOX filler and overflow tubes prior to servicing aircraft with LOX.
- Do not apply fluid when LOX carts are in vicinity of aircraft.
- Although the fluids flash points are above 93°C (200°F), the fluids should be used with care when sprayed around heater or engine exhausts or APU exhausts.
- Special care shall be exercised to prevent the excess use of fluids around cabin heater and/or ventilator air intake ducts or around the intakes of the engines and APU's. This precaution is essential to minimize the possibility of toxic fumes entering the cabin or cockpit during taxi prior to takeoff. On some aircraft, the engine bleed could be closed for a short period for dryout, before takeoff (must be approved by the respective Aircraft Single Manager).
- Extreme caution must be exercised in the use of glycol-water solutions (including MIL-A-8243/AMS 1424, Type I, AMS 1428, Type II/IV Fluids) in and around aircraft having silver or silver-coated electrical/electronic circuitry. Rapid oxidation and fire can occur when glycol-water solutions come in contact with and short across bare or defectively insulated silver or silver-coated electrical circuits such as wiring, switches, circuit breakers, etc., which are carrying Direct Current (DC).
- The AMS 1428, Type II/IV fluid can be slippery once on the ground, particularly during periods of very dry conditions.
- Position stabilizers and elevators so that deicing fluid and melted precipitation will be drained from the surface.
- When deicing any portion of an aircraft by spray method, all other maintenance operations to that aircraft shall be suspended. All but deicing personnel shall vacate aircraft vicinity during the deicing process.
- Remove ice from leading edge first and then move progressively aft.
- Do not use fluid for removal of heavy snow.
- Spray fluid from front to back on all wing/tail surfaces.
- Wear face shields, as a minimum, for eye protection when applying fluid (AFOSH STD 91-31).
- Operate spray boom slowly and cautiously. (Boom operators should be thoroughly trained in their job.)
- Use covers whenever possible.
- Inspect control surfaces for complete removal of ice, snow, and slush. Hands on (tactile) is only known positive method to date.
- Manually check control surfaces through their full range of travel to insure freedom of movement.
- Heavy accumulations of snow should be moved with either blown air or mechanically (to the maximum extent possible) prior to using deicing fluids.

CHAPTER 1
GENERAL INFORMATION

1.1 GENERAL INFORMATION.

Information provided in this chapter should provide a broad understanding of the aircraft ground deicing program being implemented and tailored to adopt much of what the FAA has already accomplished with the civilian air carriers.

1.1.1 Clean Aircraft Concept. A concept developed to ensure critical surfaces on an aircraft are free of all frozen contamination and to ensure that frozen contamination does not prevent the safe performance of an aircraft.

a. Test data has proven that ice, snow, or frost formations having a thickness and surface roughness similar to medium or coarse sandpaper on the leading edge and upper surface of a wing can reduce wing lift by as much as 30% and increase drag by 40%.

b. Wing contamination may be significantly more pronounced for hard-leading-edge (hard-wing) aircraft than for aircraft fitted with leading edge devices (slatted-wing) aircraft.

1.1.2 FAA Clean Aircraft Policy. FAA clean aircraft policy is cited in FAR 121.629, NO PERSON MAY TAKE OFF ON AN AIRCRAFT WHEN FROST, ICE, OR SNOW IS ADHERING TO THE WINGS, CONTROL SURFACES, PROPELLERS, ENGINE INLETS, OR OTHER CRITICAL SURFACES OF THE AIRCRAFT.

1.1.3 AF Policy. AF policy is consistent with the FAA policy and is cited in AFI 11-202 and reads as follows: THE PILOT IN COMMAND WILL NOT TAKE OFF WITH ICE, SNOW, OR FROST ADHERING TO THE WINGS, CONTROL SURFACES, PROPELLERS, ENGINE INLETS, OR OTHER CRITICAL SURFACES OF THE AIRCRAFT, UNLESS AUTHORIZED BY THE AIRCRAFT SINGLE MANAGER OR FLIGHT MANUAL.

1.1.4 Light Frost. A thin coating of frost is permitted on the fuselage provided letter and paint lines are visible. Requires aircraft Single Manager approval.

1.1.5 Light Frost due to Supercooled Fuel. Light frost (up to 1/8 inch thick) caused by supercooled fuel is permitted on the lower wing surface (i.e., below the fuel tank area) if the fuselage and all other control surfaces are free of any icing. If deicing is required on any other aircraft surface, the underwing frost shall also be removed. Requires aircraft Single Manager approval.

1.2 ENVIRONMENTAL CONSIDERATIONS.

1.2.1 Clean Water Act. The Clean Water Act and its amendments have established limits on what can be discharged into U.S. rivers, lakes, and streams. To meet the requirements, storm water National Pollutant Discharge Elimination System (NPDES) permits are required. Permits also require implementation of Storm Water Pollution Prevention Plans (SWPPP) and most Air Force activities require implementation of a SWPPP. This includes storm water runoffs of chemical deicers/anti-icers into the waters of the U.S. Glycol chemicals contained in the aircraft deicers/anti-icers are a major problem and their use must be minimized. Any discharge limits set in the NPDES permit must be adhered to. Discharges of deicing/anti-icing fluids to the waters of the U.S. must be minimized, reduced, or eliminated through the use of Best Management Practices (BMPs) which are listed in the SWPPP. Dry weather discharges of fluids must be captured and contained. Fluid that drips off the aircraft and flows under its own power to storm drains and then to the waters of the U.S. is called a dry weather discharge. Captured deicing/anti-icing fluids must be disposed of properly. There are several disposal options (the most common being the discharge into a Waste Water Treatment Plant). Check with the Environmental Flight to determine which option(s) to use.

1.2.2 Best Management Practices. A key provision of a SWPPP is the implementation of BMP. BMPs are designed to minimize the discharge of chemicals for deicing/anti-icing of aircraft and will vary by location. BMPs are published in AF/CEVQ document, INTERIM GUIDANCE POLLUTION PREVENTION AND BEST MANAGEMENT PRACTICES FOR AIRCRAFT AND AIRFIELD DEICING/ANTI-ICING OPERATIONS.

1.3 AIRCRAFT DEICING.

1.3.1 Deicing Methods. Deicing is the process of removing accumulations of snow, frost, slush, and/or ice from the aircraft critical surfaces, crevices, additional openings, and hinge points of an aircraft. This can be accomplished by brushing, blowing, wiping, and by spraying heated deicing fluid.

1.4 AIRCRAFT ANTI-ICING.

1.4.1 Anti-Icing Methods. Anti-icing is the process of preventing further accumulations of snow, frost, slush, and/or ice on clean aircraft critical surfaces by the application of fluids. The anti-icing fluids used to prevent ice or snow forming, or accumulating, have HOLDOVER time during which their application prevents the formation of ice or snow crystals.

1.5 PROFESSIONAL DEICING SOCIETIES.

1.5.1 Societies. Current deicing/anti-icing materials and procedures are being developed and coordinated by three professional societies.

a. Society of Automotive Engineers (SAE).

b. International Standards Organizations (ISO).

c. Association of European Airlines (AEA).

1.5.2 Society of Automotive Engineers (SAE).

1.5.2.1 G-12 Committee. The guidance and procedures for the use of fluids are coordinated by Committee G-12 (Aircraft Ground Deicing) of the SAE. This Committee is a voluntary membership of individuals from the FAA, AEA, ISO, Civilian Airline Carriers, Aircraft Manufacturers, Fluid Suppliers, Equipment Manufacturers, SAE, NASA, Canadian interests, European interests, and DoD activities.

a. The collective effort of the Committee publishes Aerospace Recommended Practices (ARP) 4737, Aircraft Deicing/Anti-Icing Methods with Fluids.

b. Holdover Tables developed by SAE Committee G-12 can be obtained from the website in Paragraph 7.3.1.1, Step a.

1.6 AIR FORCE SINGLE MANAGER.

1.6.1 Weapon System Life Cycle. Life Cycle management of all phases of the life of a Weapon System (e.g., aircraft, missile, engine, etc.) in the Air Force is the responsibility of an individual known as the Single Manager. The definition of Single Manager is often expanded to include the staff associated with this person.

a. The Single Manger is responsible to the Major Air Commands (MAJCOMs) for supporting the Weapon System through all phases of the system's life. Support includes but is not limited to design, acquisition, engineering, modifying, providing procedures, item management, technical data, etc.

b. Single Managers shall adopt and/or modify the procedures and methods in this document for the deicing/anti-icing program on their respective weapon system.

1.7 PRECEDENCE OF TECHNICAL DATA.

1.7.1 Precedence. This document does not specify requirements for particular aircraft models/design/series.

a. Aircraft Single Managers, aircraft specific Technical Orders, aircraft manufacturers' manuals, procedures, or methods are the final authority for deicing/anti-icing procedures. These documents can adopt or supplement the information contained herein.

b. In all cases, aircraft specific technical orders shall take precedence over this document.

1.8 RUNWAY/ROADWAY DEICING AND ANTI-ICING.

1.8.1 Air Force Instruction (AFI) for Airfields. Airfield ground deicing/anti-icing information and authorized materials are contained in AFI 32-1045 Office of Primary Responsibility (OPR): HQ Air Force Civil Engineering Agency (AFCESA)/CEOM).

1.9 AIRCRAFT DEICING/ANTI-ICING FLUIDS.

1.9.1 Specifications. Three fluid specifications are authorized for use in the deicing/anti-icing of aircraft.

a. MIL-A-8243, Type I and Type II; Deicing fluids.

b. AMS 1424, Type I; Deicing fluid.

c. AMS 1428, Type II and Type IV; Anti-icing fluids.

Type II/IV fluids are designed for large transport aircraft with takeoff rotational speeds that generally exceed approximately 100 to 110 knots and have a takeoff ground roll time of not less than 23 seconds.

1.10 IMPLEMENTATION OF COMMERCIAL FLUIDS.

Use of commercial SAE (AMS), ISO, AEA equivalent fluids on Air Force aircraft shall be accomplished using instructions from the Aircraft Single Manager for that particular aircraft.

1.11 SAE (AMS), ISO, AEA CODE INTERCHANGE ABILITY/EQUIVALENCY.

International cooperation in the deicing community has resulted in the interchangeability of SAE (AMS), ISO and AEA specifications, procedures, and codes. When AMS 1424 and 1428 references are made in this Technical Order, they are completely interchangeable with the respective ISO and AEA codes shown in Table 1-1. This equivalency information shall be placed in both aircrew Dash One Technical Orders and appropriate aircraft specific maintenance series Technical Orders for aircraft that transit overseas locations.

Table 1-1. SAE (AMS)/ISO/AEA Codes

SAE	ISO	AEA
ARP 4737	ISO 11076	NONE
AMS 1424, Type I	ISO 11075, Type I	AEA, Type I
AMS 1428, Type II	ISO 11078, Type II	AEA, Type II
AMS 1428, Type IV	NONE	AEA, Type IV

NOTE

Holdover times are estimates and are to be used as guidelines.

1.12 HOLDOVER TIME.

1.12.1 Estimated Time. Holdover time is the estimated time an anti-icing fluid prevents the formation of ice, snow, frost, or slush from reforming on surfaces under conditions of freezing precipitation.

a. The time is a factor of fluid type, concentration, Outside Air Temperature (OAT), Aircraft Skin Temperature (AST), and various weather conditions (type of freezing precipitation occurring).

b. This time can be shortened in heavy weather conditions, heavy precipitation rates, or high moisture rates, high wind velocity or jet exhaust blast.

1.13 FLUID BUFFER (FREEZING POINT TEMPERATURE BUFFERS).

1.13.1 General.

a. The residual fluid on the aircraft surfaces following the deicing/anti-icing operation shall have a freezing point temperature (Buffer Temperature) which is below the OAT or AST. OATs shall be obtained from an official weather source and updated at least hourly during periods of deicing. Aircraft temperature gages are not acceptable for obtaining OAT.

b. Generally, the holdover time increases with the expansion of the buffer. However, this requires the use of more glycol which results in more expense, more spillage, and runoff to be collected.

c. Fluid buffer temperatures provide a margin of safety.

d. AST will differ from the OAT only when an aircraft lands with cold soaked fuel. Otherwise, assume they are the same.

1.13.2 AMS 1424, Type I Fluid Buffer. The freeze point of the AMS 1424, Type I mixture shall be at least 18°F (10°C) below the OAT or AST (whichever is lower).

1.13.3 AMS 1428, Type II/IV Fluid Buffer. The freeze point of the SAE, Type II/IV concentrated fluid shall be at least 13°F (7°C) below the OAT or aircraft skin temperature (whichever is lower).

1.13.4 MIL-A-8243, Type I/II Fluid Buffer. Before the conversion to SAE fluids, the MIL-A-8243, Type I/II fluids did not have established fluid buffer temperatures. The freeze point of the MIL-A-8243, Type I/II mixture shall be at least 18°F (10°C) below the OAT or AST (whichever is lower).

1.14 LOWEST OPERATIONAL USE TEMPERATURES (LOUT).

Values are found in APPENDIX B through APPENDIX D.

1.14.1 Aerodynamic Testing. SAE fluids are cold wind tunnel tested for conformance to a high speed aerodynamic acceptance test developed by the Aerospace Industries Association (AIA). Details of the test are included in the respective specification.

a. Testing is accomplished by an independent laboratory on each supplier's fluid before being qualified to the AMS specifications.

b. Each supplier's fluid has a Lowest Operational Use Temperature (LOUT) established for each authorized mixture ratio (fluid/water). This is the lowest temperature at which the fluid was tested.

1.14.2 No Military Specification Testing. MIL-A-8243 fluids have never been cold wind tunnel tested.

An Estimated Lowest Operational Use Temperature (ELOUT) has been established for each authorized mixture ratio (fluid/water). Values are found in APPENDIX E.

1.15 WEATHER RELATED INFORMATION.

a. Accurate and timely weather information is absolutely critical to an effective aircraft deicing/anti-icing program.

b. OAT readings shall be obtained from the official airfield weather source. Temperature readings will be updated at least hourly during periods of deicing. Aircraft instruments shall not be used for determining the OAT.

c. Weather conditions involving frozen precipitation (snow, icing, etc.) shall be updated at least every 20 minutes during periods of deicing/anti-icing operations.

1.16 CONSUMABLE MATERIAL.

Support material and expended items that will be consumed during normal operation and maintenance procedures are listed in Table 1-2.

Table 1-2. Consumable Materials

Specification	Nomenclature Material	Part No., NSN, FSN, CAS No.
MIL-A-8243, Type I	Anti-icing and Deicing Defrosting Fluid, 55-gallon Drum	6850-01-281-0338
MIL-A-8243, Type I	Anti-icing and Deicing Defrosting Fluid, 5-gallon	6850-01-281-0340
MIL-A-8243, Type I	Anti-icing and Deicing Defrosting Fluid, Bulk	6850-01-281-0339
AMS 1424, Type I	Anti-icing and Deicing Defrosting Fluid, 5-gallon	6850-01-435-6468
AMS 1424, Type I	Anti-icing and Deicing Defrosting Fluid, 55-gallon Drum	6850-01-435-6465
AMS 1424, Type I	Anti-icing and Deicing Defrosting Fluid, Bulk	6850-01-435-6471
AMS 1424, Type I	Anti-icing and Deicing Defrosting Fluid, 275-gallon Tote	6850-01-449-9469
AMS 1428, Type II	Anti-icing and Deicing Defrosting Fluid, 5-gallon	6850-01-435-6470
AMS 1428, Type II	Anti-icing and Deicing Defrosting Fluid, 55-gallon Drum	6850-01-435-6469
AMS 1428, Type II	Anti-icing and Deicing Defrosting Fluid, Bulk	6850-01-435-6466
AMS 1428, Type IV	Anti-icing and Deicing Defrosting Fluid, 5-gallon	6850-01-450-4752
AMS 1428, Type IV	Anti-icing and Deicing Defrosting Fluid, 55-gallon Drum	6850-01-450-4750
AMS 1428, Type IV	Anti-icing and Deicing Defrosting Fluid, Bulk	6850-01-450-4747
AMS 1428, Type IV	Anti-icing and Deicing Defrosting Fluid, 275-gallon Tote	6850-01-449-9473
MIL-A-8243, Type II	Anti-icing and Deicing Defrosting Fluid, 5-gallon	PROCUREMENT PER THIS DOCUMENT NOT AUTHORIZED
MIL-A-8243, Type II	Anti-icing and Deicing Defrosting Fluid, 55-gallon Drum	PROCUREMENT PER THIS DOCUMENT NOT AUTHORIZED
MIL-A-8243, Type II	Anti-icing and Deicing Defrosting Fluid, Bulk	PROCUREMENT PER THIS DOCUMENT NOT AUTHORIZED

CHAPTER 2
AIRCRAFT CONDITIONS IN COLD WEATHER

2.1 GENERAL.

Aircraft are faced with a number of different problems when exposed to cold weather and frozen precipitation. This chapter will describe some of those conditions and concerns associated with those conditions. Also included is a recommended methodology for flying activities to organize their aircraft ground deicing operations.

2.1.1 Cold Soaked Aircraft.

a. Aircraft that is outside in extreme weather conditions present unusual problems concerning deicing.

b. Ground crews performing maintenance operations often use supplemental heat inside the aircraft to perform their assigned tasks. The potential for a localized thaw/refreeze cycle exists due to this condition. During the thaw cycle, melted precipitation can relocate into areas not normally expected.

c. Actual field experience is the best source of information for this condition, aircraft Single Managers shall work with their MAJCOMs to determine if there are specific areas of concern.

2.1.2 Flight Controls.

a. Control surfaces should be set so melting snow and rain does not run into balance bays and other cavities.

b. Flight controls may require specialized deicing or handling prior to deicing operations.

2.1.3 Landing Gear. Wheels, brakes, electrical harness, position and safety switches, and their operating linkages, etc., shall be clear of ice, snow, or accumulation of slush. Specialized deicing procedures may be required.

2.1.4 Engines.

a. Inspect engine intake and exhaust areas immediately after shutdown for the presence of ice formations which should be removed before the engine plugs and protective covers are installed. Residual heat from the engine could melt ice, allowing water to puddle and refreeze the compressor or fan lower blade tips.

b. During or after snowfall, freezing rain, or sleet, the engine should not be started until the inlet and tailpipe has been checked. Inlets shall be free of frozen contamination.

c. Aircraft, with rear mounted engines, are highly susceptible to problems unless the entire fuselage and wings are clear of ice and snow.

2.1.5 Sensors (Pitot-Static Systems). Warm air may be required to melt ice/snow and dry these areas.

2.1.6 Cavities. Openings (e.g., engine inlets, engine exhausts, balance bays, gear wells, etc.) are susceptible to wind driven snow being blown into them during periods of heavy weather. Identify potential areas and treat accordingly.

2.1.7 Thrust Reversers. Ensure that snow or slush is not trapped after thrust reversers are deployed over poorly drained or slushy runways.

2.1.8 Clear Ice.

a. When frozen precipitation covers clear ice, potential exists for deicing personnel to overlook ice that remains after the removal of snow or sleet.

b. Deicing or anti-icing fluids may camouflage the clear ice by leaving a shiny surface that gives the appearance of a clean surface. Clear ice at the aircraft wing root area is particularly difficult to see from the ground or deicing basket on large aircraft.

c. Clear ice can form in the vicinity of the fuel tanks, on wing upper surfaces, as well as underwing. Aircraft are most vulnerable when the following exists:

(1) Wing temperatures remain below 32°F due to the cold fuel.

(2) Ambient temperatures between 28° and 59°F are present.

(3) Precipitation occurs while the aircraft is on the ground.

(4) When frost or ice is present on the lower surface.

d. During post deicing/anti-icing contamination checks, verify the aircraft is free of ice that may be obscured by deicing fluids.

e. Aircraft with rear mounted engines are especially susceptible to ice that may shed from a wing root area or landing gear assembly during takeoff or flight.

f. Tactile (hands on) checks may be the only method of verification. A hands on check is the physical touching of aircraft skin for roughness (no ice) or smoothness (ice present). Prefer gloves be off during the inspection. In extremely cold weather, use an eraser end of a pencil for verification. Lightly push the eraser end against the surface. If there is resistance, there is no ice present. If the eraser glides freely over the surface, there is ice present.

2.1.9 Aircraft Deicing/Anti-Icing Operations.

a. Deicing/anti-icing operations involves numerous functions on an installation and each organization operates under its own guidelines.

b. AFI 32-1045 (Civil Engineering - SNOW AND ICE CONTROL) requires each installation with over 6 inches average annual snowfall maintain a Snow and Ice Control Plan (S&ICP) and form a Snow and Ice Control Committee (S&ICC).

c. Each installation involved with aircraft deicing/anti-icing operations shall consider the formation of a similar committee or expanding the role of their S&ICC to include aircraft deicing/anti-icing. Membership on this new or expanded committee shall include all tenant flying organizations on the base.

d. The formation of a new committee or an expanded role of the existing S&ICC is a MAJCOM decision. Regardless of how or if said committee is formed, there shall be a clear and defined description of the roles and responsibilities of each participating organization.

e. There shall be designated by a definition of duties and qualifications, a specific duty position for the individual(s) who shall monitor the conduct of all facets of the effort during aircraft deicing/anti-icing operations. Qualifications and training required to fill this position shall be described in either a Plan or Operating Instruction.

f. Typically, this specific duty position would be applicable to the Supervisor of Flying (SOF), Command Post Personnel and/or a Maintenance Supervisor.

g. MAJCOMs should consider reviewing local Plans or Operating Instructions. The implementation of a process similar to this will mirror the requirements of the FAA with respect to the civilian aviation community. Each carrier must develop and maintain an FAA approved plan that is site specific.

2.1.10 Deicing/Anti-Icing Pad Location.

a. Location of the deicing/anti-icing pad can be important when using the AMS 1428, Type II/IV fluids.

b. Primary benefit of the Type II/IV fluid is their ability, as an anti-icing fluid, to remain on the surface until a specified amount of stress is applied (as occurs during take off). The performance characteristics of the fluid may be degraded by stress generated from another aircraft exhaust.

c. It is important that deicing/anti-icing pads not be situated in areas subject to aircraft exhaust from taxiing or turning aircraft.

CHAPTER 3
AIRCRAFT DEICING/ANTI-ICING FLUIDS

3.1 GENERAL.

3.1.1 Military Specification MIL-A-8243. Military Specification MIL-A-8243 which identifies two types of deicing fluid, Type I and Type II, has been cancelled. Replacement procurement must be made with AMS 1424, Type I approved fluid. Existing stocks of MIL-A-8243 Specification fluid shall be used only until the stock is depleted.

NOTE

Only in extreme circumstances shall fluid mixtures be used when the OAT is lower than the ELOUT of the fluid. MAJCOM approval is required for operations when the OAT is below the ELOUT.

3.1.1.1 MIL-A-8243, Type I/II ELOUT. Normally, the fluid mixture shall not be used at temperatures lower than the ELOUT. MAJCOM approval is required if the OAT is below the ELOUT. See APPENDIX E for appropriate mixtures.

3.1.2 AMS 1424, Type I (Deicing Fluid).

a. AMS 1424, Type I fluids are proprietary Newtonian fluids. A typical Newtonian fluid is water.

b. Newtonian fluids exhibit viscosity's that are shear and time independent. The fluid will begin to move immediately upon application of stress; it has no yield stress to overcome before flow begins.

c. The AMS 1424 specification does not specify that the fluid be glycol based. Under current Air Force policy, only propylene glycol based fluids shall be procured due to operational problems presently being experienced with the non-glycol based fluids. An Air Force aircraft being deiced/anti-iced at locations (commercial, international, other service) other than an Air Force installation can be deiced/anti-iced with any qualified AMS fluid. This includes ethylene glycol based fluids. The restriction on procuring only propylene glycol based fluids versus ethylene glycol based fluids is based on potential environment degradation rather than performance concerns. As new non-glycol based formulations of AMS 1424 become available they will be evaluated for materials compatibility and proper operational performance prior to their incorporation into this Technical Order. The development of glycol free formulations is being driven by environmental concerns.

3.1.2.1 Crossmixing. Fluids conforming to AMS 1424, Type I differ in chemical composition from manufacturer to manufacturer and are not required to be compatible.

a. Mixing of AMS 1424, Type I fluids from different manufacturers or with MIL-A-8243 fluids should be done so that the residual is small compared to the amount added.

(1) If the residual in the storage tank is no more than 10% of the final volume, the identity of the mixed fluid shall be the same as the added product.

(2) If the residual is greater than 10%, contact Det 3, AFPET/AFTT, Wright-Patterson AFB, OH 45433-7632, for specific instructions.

b. AMS 1424, Type I fluid or MIL-A-8243 fluids shall not be crossmixed with AMS 1428, Type II/IV. Example: never crossmix an Octagon, Type I fluid with an Octagon, Type II/IV fluid. Should there be an accidental crossmixing of fluids as described above, the resulting mixture shall be sent to disposal. There shall be no exceptions to this requirement.

3.1.2.2 Same Appearance as Hydraulic Fluid. Most fluid suppliers provide the Type I fluid in an orange-red color. It can give the appearance of hydraulic fluid and since some aircraft have aerodynamic quiet areas, fluid can build up and may not shear off during flight. It may appear as hydraulic fluid leaks upon landing. Check to ensure indications are not the AMS 1424, Type I fluid.

NOTE

Only in extreme circumstances shall fluid mixtures be used when the OAT is lower than the LOUT of the fluid. MAJCOM approval is required for operations when the OAT is below the fluid LOUT.

3.1.2.3 AMS 1424, Type I LOUT. Normally the fluid mixture shall not be used at temperatures lower than the fluid suppliers recommended LOUT. MAJCOM approval is required if the OAT is below the LOUT. See APPENDIX B for appropriate mixture.

3.1.2.4 AMS 1424, Type I Hard Water Compatibility. Since this fluid is supplied in the 100% concentrate form (NEAT), it shall be diluted with water before deicing operations. Water with a hardness that exceeds 350 ppm hardness may cause corrosion inhibitors to precipitate out thereby reducing corrosion inhibition for storage systems. Installations using water with a hardness exceeding 350 ppm shall contact the fluid supplier for any required guidance.

3.1.3 AMS 1428, Type II/IV (Anti-Icing Fluid).

NOTE

The AMS 1428, Type II/IV fluids have been tested for conformance to the high speed aerodynamic acceptance test developed by the AIA. Each Aircraft Single Manager shall determine if there are any adverse performance affects in using these fluids before authorizing their use.

a. Type II/IV fluids are proprietary non-Newtonian (pseudoplastic) fluids.

b. Non-Newtonian, pseudoplastic fluids are defined as fluids whose viscosity's are shear and time dependent and whose shear rate is not directly proportional to its shear stress. The fluid will not begin to move immediately upon application of a stress. It has a yield stress to overcome before flow begins.

c. Non-Newtonian fluids revert to their original flow behavior once the applied stress is removed. This property allows Type II/IV fluids to exhibit longer holdover times as anti-icers, which means they will last longer in conditions of precipitation. This property allows time for the aircraft to depart once the anti-icer has been applied (before the formation of ice would prevent takeoff).

d. The fluid will begin to shear from the aircraft on takeoff when the aircraft reaches approximately 75 – 85 knots of indicated airspeed. AMS 1428, Type II/IV fluids are to be used only on aircraft with rotation speeds generally higher than approximately 100 – 110 knots. Fluids are applicable only to fixed wing aircraft.

e. The SAE specification does not specify that the fluid be glycol based but all current qualified suppliers are either ethylene or propylene glycol based. Under current Air Force policy, only propylene based fluids shall be procured due to environmental concerns. An Air Force aircraft being deiced/anti-iced at locations (commercial, international, other service) other than an Air Force installation can be deiced/anti-iced with any qualified SAE fluid. This includes ethylene glycol based fluids. The restriction on using only propylene glycol based fluids is based on environment conditions, not performance.

3.1.3.1 Performance Concerns. FAA guidance (AC 120-58) states that some large aircraft may experience performance degradation and many require weight reduction or other takeoff compensation. Degradation may be significant on smaller aircraft and testing has not been as extensive as has occurred on larger aircraft. Each Aircraft Single Manager shall review this factor before authorizing these fluids. Consideration of this factor shall require more analysis for hard-leading-edge (hard-wing) aircraft than for slatted-leading-edge (slatted-wing). Aircraft manufacturers are the best source of information concerning potential aircraft performance degradation since they have previously evaluated their commercial aircraft. Aircraft Single Managers shall ensure the manufacturer is aware of the current aircraft exterior coatings (surface finish unlike those used by Commercial Airlines), aircraft configuration, and any unique mission requirements. Typical performance related concerns are but are not limited to:

a. Surface finish that is rougher than a typical commercial aircraft.

b. Composite materials with specialized coatings.

c. Aerial refueling.

d. Formation takeoffs (including cell formations). Especially the number two aircraft (wingman) on a 2-ship formation takeoff.

e. Low observable surfaces that have special performance characteristics.

f. Short field takeoffs (minimum runway length and obstacle clearance).

g. Using reverse pitch on propellers to back aircraft.

h. External stores (pylons, weapons, ECM pods, Navigational pods, etc.).

i. Aircraft without wing leading edge devices (hard-wing versus slatted-wing).

3.1.3.2 Crossmixing. Fluids conforming to AMS 1428, Type II/IV differ in chemical composition from manufacturer to manufacturer and are not required to be compatible. Never crossmix AMS 1428, Type II/IV fluids from different manufacturers. For example, never crossmix an Arco, Type II fluid with an Octagon, Type II fluid. Also, never crossmix an Arco, Type IV fluid with an Octagon, Type IV fluid.

WARNING

The crossmixing of fluids from different AMS, Type II/IV suppliers will result in unknown aerodynamic properties.

a. AMS 1428, Type II/IV fluids shall not be crossmixed with MIL-A-8243, Type I/II fluids.

b. AMS 1428, Type II fluid shall not be crossmixed with AMS 1428, Type IV. Example: never crossmix an Octagon, Type II fluid with an Octagon, Type IV fluid.

c. Should there be an accidental crossmixing of fluids as described above, the resulting mixture shall be sent to disposal. There shall be no exceptions to this requirement.

3.1.3.3 AMS 1428, Type II/IV LOUT. Do not use the fluid mixture at temperatures lower than the fluid suppliers recommended LOUT. See APPENDIX C (Type II) and APPENDIX D (Type IV) for values.

WARNING

A fluid mixture shall not be used when the Outside Air Temperature (OAT) or skin temperature of the aircraft is lower than the LOUT of the fluid. This will result in unknown aerodynamic properties.

a. Exception – the LOUT for conditions of freezing drizzle and light freezing rain is limited to 14°F (–10°C) and is reflected in Holdover Tables.

b. This temperature restriction is higher than any supplier's LOUT but is based on actual data taken during periods of freezing drizzle and light freezing rain. Typically, freezing drizzle or light freezing rain does not occur at temperatures lower than 14°F (–10°C).

3.1.3.4 Applied over Different Supplier's Deicing Fluid. AMS, Type II/IV can be applied over different suppliers MIL-A-8243, Type I or AMS 1424, Type I if the fluid supplier of the AMS, Type II/IV agrees. Call the fluid supplier of the AMS, Type II/IV and provide the needed information for evaluation.

3.2 HANDLING – RECEIPT OF FLUID.

Upon receipt of fluid and before unloading, read product label and shipping papers, and perform visual checks of the fluid before being transferred. Typically, the Chemical Data Section (Section 4, Chemical Data or Section 12, Physical and Chemical Data – Appearance and Odor) of the suppliers MSDS describes the appropriate color to look for. If the fluid passes a visual check, then the fluid's refractive index (freeze point) shall be checked before unloading. Freezing Point/Refractive Index Tables from various suppliers are included as APPENDIX B through APPENDIX E. For suppliers data not included in APPENDIX B through APPENDIX E, contact Det 3, WR-ALC/AFTT, 2430 C Street, Bldg 70, Area B, Wright-Patterson AFB, OH 45433-7632.

3.2.1 Handling – Transfer of Fluid (MIL-A-8243, Type I/II, AMS 1424, Type I). Special precautions (other than normal) are not required with either the MIL-A-8243, Type I/II or AMS 1424, Type I fluids. Measure on a regular basis, the refractive index of the fluid to ensure it has not degraded. Recommend the minimum interval be at least monthly during the deicing season.

Checks made on the fluid at the deicing equipment prior to use can be used to satisfy this requirement, if these checks occur monthly.

3.2.2 Handling – Transfer of Fluid (AMS 1428, Type II/IV).

CAUTION

Use of incorrect equipment in either transferring or applying this fluid can result in a loss of 20 – 60% of its properties.

3.2.2.1 Handling Is Critical. The handling of the AMS 1428, Type II/IV fluids is critical to prevent damage to the fluid's properties. Do not use pumps or transfer equipment not recommended by the fluid supplier. Just as the fluid can be damaged with the improper equipment while being applied to the aircraft, it can be damaged while being transferred into or out of the storage containers.

a. This fluid (AMS 1428, Type II/IV) shall be applied with equipment using pumps that do not result in mechanical shearing. The majority of all Air Force deicing equipment uses pumps that are centrifugal or reciprocating and these type pumps can destroy the fluid's anti-icing properties.

b. Before implementing the AMS 1428, Type II/IV fluids, ensure that either the installation or the deicing contractor has the correct equipment.

c. Use low shear diaphragm or positive displacement pumps, avoid centrifugal or reciprocating pumps. Transfer through lines that provide for flows of less than 10 feet per second for a pressurized line or 4 feet per second for a suction line. Avoid unnecessary bends or elbows in piping.

d. If there are any questions concerning proper pumps or lines, contact the fluid supplier.

e. Measure on a regular basis, the refractive index of the fluid to make sure it is not degraded. Recommend the minimum interval be at least monthly during the deicing season.

NOTE

Conspicuously label/mark storage tanks, loading and transfer lines, pumps, valves, etc., with the type of fluid used to minimize fluid contamination and aid with identification. Colored weather proof tags which are the same color as the fluid is one means of accomplishing this labeling process.

3.3 STORAGE CONTAINERS – MIL-A-8243, TYPE I/II, AMS 1424, TYPE I.

Storage containers shall be marked/stenciled with a clear identification of the supplier's product name and the type of fluid.

3.3.1 Construction. Storage tanks constructed of stainless steel, reinforced plastic (polyethylene), or mild steel are preferred. If mild steel is used, an inner liner that is chemically resistant is preferred. If mild steel without a liner is used, corrosion will be a significant problem.

3.3.2 Inspection.

CAUTION

Galvanized steel shall never be used for a tank material. The fluid will attack the galvanize and result in serious corrosion problems.

Storage containers shall be inspected annually for deterioration. If mild steel tanks (without a liner) are used, corrosion most often occurs in the vapor space of partially empty tanks by evaporation and subsequent condensation of water from the fluids. To reduce the corrosion, keeping tanks full of fluid during the summer and other periods of low use is an option.

3.3.3 Cleaning. Cleaning shall be accomplished any time contamination appears to be a problem. Cleaning procedure is to drain all the remaining fluid, water wash, and drain. The tank is now ready to be filled. The wash water must be disposed of properly in accordance with local environmental regulations.

WARNING

The crossmixing of fluids from different AMS, Type II/IV suppliers will result in unknown aerodynamic properties. Tanks shall be cleaned if changing fluid suppliers.

a. Cleaning procedure is to drain all the remaining fluid, water wash, and drain. The tank is now ready to be filled. The wash water must be disposed of properly in accordance with local environmental regulations. Check with the Environmental Flight for disposal options.

b. Cleaning shall also be accomplished any time contamination appears to be a problem. Cleaning procedure is to drain all the remaining fluid, water wash, and drain. The tank is now ready to be filled. The wash water must be disposed of properly in accordance with local environmental regulations.

3.4 STORAGE CONTAINERS – AMS 1428, TYPE II/IV.

WARNING

The crossmixing of fluids from different AMS, Type II/IV suppliers will result in unknown aerodynamic properties. Tanks shall be cleaned if changing fluid suppliers.

NOTE

Conspicuously label/mark storage tanks, loading and transfer lines, pumps, valves, etc., with the type of fluid used to minimize fluid contamination and aid with identification. Colored weather proof tags which are the same color as the fluid is one means of accomplishing this labeling process.

Each AMS brand fluid is unique to its manufacturer and shall not be crossmixed or blended with other brands. AMS 1428, Type II and AMS 1428, Type IV fluids shall be stored in separate containers. Storage containers shall be marked/stenciled with a clear identification of the supplier's product name and the type of fluid.

3.4.1 Construction. Storage tanks shall be constructed of stainless steel or reinforced plastic (polyethylene). Stainless steel is the preferred material. If mild steel is used, it shall have an inner liner that is chemically resistant.

a. Pipes and fittings shall be stainless steel.

b. Type II/IV fluids are susceptible to ultraviolet light. Clear/opaque polyethylene tanks shall be painted a dark color or shielded to reduce this tendency.

3.4.2 Inspection. Storage containers shall be inspected annually for deterioration. If mild steel tanks are used (even with a liner), corrosion most often occurs in the vapor space of partially empty tanks by evaporation and subsequent condensation of water from the fluids. The chemically resistant liner required if mild steel is used may prevent the corrosion. To prevent corrosion, 1 option is to keep tanks full of fluid during the summer and other periods of low use.

3.4.3 Cleaning. Cleaning of tanks and lines shall be accomplished if a different supplier's fluid is received. Never add a different supplier's fluid to a different supplier's fluid that is already in the tank. Never add Type II and Type IV together. The tank and lines shall be drained and cleaned before fluid suppliers or types are changed.

a. Cleaning procedure is to drain all the remaining fluid, water wash, and drain. The tank is now ready to be filled. The wash water must be disposed of properly in accordance with local environmental regulations. Check with the Environmental Flight for disposal options.

b. Cleaning shall also be accomplished any time contamination appears to be a problem. Cleaning procedure is to drain all the remaining fluid, water wash, and drain. The tank is now ready to be filled. The wash water must be disposed of properly in accordance with local environmental regulations. Check with the Environmental Flight for disposal options.

3.5 LONG TERM STORAGE (SHELF-LIFE) MIL-A-8243.

Storage, update testing, and quality control of MIL-A-8243 product shall be in accordance with T.O. 42C-1-12, Quality Control of Chemicals.

3.6 LONG TERM STORAGE (SHELF-LIFE) AMS 1424, TYPE I.

Commercial Type I fluids shall be stored in accordance with manufacturer's recommendations. If sufficient fluid is remaining after a winter season, quality control and update testing shall be accomplished in accordance with T.O. 42C-1-12, Quality Control of Chemicals.

3.7 LONG TERM STORAGE (SHELF-LIFE) AMS 1428, TYPE II/IV.

Commercial Type II/IV fluids shall be stored in accordance with manufacturer's recommendations. If sufficient fluid is remaining after a winter season, quality control and update testing shall be accomplished in accordance with T.O. 42C-1-12, Quality Control of Chemicals.

3.8 DILUTION OF FLUIDS.

3.8.1 Military Specification MIL-A-8243.

a. Premix solutions shall be heated and diluted with water. The mixture strength is based on OAT or AST (whichever is lower) and the selection of the appropriate ELOUT from APPENDIX E.

(1) Example – the OAT is +01°F. The correct solution of MIL-A-8243, Type I from APPENDIX E is 50/50.

(2) Do not confuse this with the freezing point (+01°F) of a 40/60 mixture of Type I fluid from APPENDIX E.

b. To avoid operational difficulties with equipment, such as freezing of the fluid-water mixture, the mixture shall be checked for the freezing point prior to use.

c. Additional information concerning use of calculated premix ratios are discussed in the segment on AMS 1424, Type I fluids.

d. Temperature of heated solution is in the range of 160 – 200°F, desired temperature is 180°F.

3.8.2 AMS 1424, Type I.

a. Premix solutions shall be heated and diluted with water. The mixture strength is based on the OAT or AST (whichever is lower) and the selection of the appropriate LOUT.

(1) Example – the OAT is –02°F. The correct solution of Octaflo or ArcoPlus from APPENDIX B is 55/45.

(2) Do not confuse this with the freezing point (–02°F) of a 40/60 mixture of either fluid from APPENDIX B.

b. A standard Premix of 50/50 will accommodate most conditions but this practice is discouraged. Using a standard Premix without regard to the true requirement can result in increased glycol usage and subsequent pollution expenses. Using a calculated Premix will avoid the glycol overuse.

c. Advantages of a Premix are:

(1) Operator does not have to stop and take a refractive index reading during deicing operations at the aircraft.

(2) Improved deicing efficiency due to more consistent application temperatures.

(3) Avoidance of freezing the water in lines that transfer water to the proportional mixing control valve.

(4) Full use of deicing equipment and water tank capacity.

d. Disadvantages of a Premix are:

(1) Higher use of glycol than required if an arbitrary mixture ratio is chosen rather than calculating the required mixture during deicing equipment loading.

(2) Chance of making an error in calculating the correct gallons of both fluid and water required for the fluid/water mixture.

e. Advantages of a Propmix are – do not have to calculate gallons of either fluid or water when loading deicing equipment.

f. Disadvantages of a Propmix are:

(1) Loss of overall mixture capacity (fluid and water) of up to 54% (dependent upon ratio) for the current deicing truck.

(2) Loss of overall mixture capacity (fluid and water) of up to 66% (dependent upon ratio) for the new deicing truck.

(3) Loss of deicing efficiency (inconsistent or low temperatures) due to mixing cold fluid and hot water at the proportional valve.

(4) No visual indication of an improper fluid/water mixture if there is a proportional valve problem during application.

g. Use APPENDIX B for determining the correct ratio.

h. Temperature of heated solution is in the range of 160 – 200°F, desired temperature is 180°F.

i. Maximum application pressure of heated solution is 200 psi. Typical application pressures are 150 – 200 psi. Nozzle flow settings depend on substance being removed. Frost removal can be accomplished with approximately 30 gpm while ice or frozen snow may require up to 80 gpm.

j. Aircraft Deicing Fluid Blending Systems – There are commercial deicing fluid blending systems available that enable personnel to select the appropriate mixture ratio depending upon real time ambient temperatures. Personnel select the necessary deicing fluid/water mixture required to meet the LOUT for that day. This saves money when compared to locations that use a premixed solution by reducing the amount of glycol used.

3.8.3 AMS 1428, Type II/IV.

a. The solution shall never be diluted and shall be applied cold at a mixing ratio of 100/0 for maximum effectiveness. Use of this fluid shall be limited to anti-icing operations.

b. Temperature of the solution shall be cold.

c. Nozzle flow settings are approximately 50 – 60 psi, 20 – 25 gpm.

d. Use APPENDIX C (AMS 1428, Type II) or APPENDIX D (AMS 1428, Type IV) for determining the LOUT and refractive index. Mixing ratios of 75/25 and 50/50 are shown only because they are identified in Holdover Tables.

3.9 SAMPLING OF DILUTED DEICING FLUID SOLUTIONS PRIOR TO APPLICATION (MIL-A-8243, TYPE I/II OR AMS 1424, TYPE I).

3.9.1 Premix. Premixed deicing fluids will be measured with a handheld refractometer at the storage tank upon initial receipt and once a week during the deicing season. The refractive index will then be used to determine the freezing point of the fluid using the appropriate table found in the Appendix (APPENDIX B for AMS 1424, Type I fluids, and APPENDIX E for MIL-A-8243 fluids). The premixed deicing fluid will have an appropriate LOUT for the temperature ranges/forecast expected for that location.

3.9.2 Propmix. The solution being sprayed from the nozzle shall be sampled and tested for freezing point immediately after initial startup, after readjustment of the proportional mixing system, and after every 30 minutes of operation. Use the handheld glycol tester to measure the freezing point and compare with the appropriate appendix (AMS 1424, Type I, APPENDIX B or MIL-A-8243, Type I/II, APPENDIX E).

3.10 SAMPLING OF ANTI-ICING FLUID SOLUTIONS PRIOR TO APPLICATION (AMS 1428, TYPE II/IV).

3.10.1 Not Required. One hundred percent fluid does not require sampling before each application. Monthly samples using a refractometer shall be tested according to Paragraph 3.9.1.

3.11 DETERMINATION OF FREEZING POINT.

3.11.1 Using Handheld Refractometer or Glycol Tester. Each instrument has advantages and disadvantages and capabilities. Follow the procedures and recommendations outlined in Paragraph 5.2.8.

3.12 UNUSED DEICING FLUID SOLUTIONS (DILUTED).

3.12.1 MIL-A-8243, Type I. Unused diluted mix of Type I deicing fluid, once prepared for application, shall not be returned into bulk storage tanks which contain specification grade MIL-A-8243, Type I product. All diluted mix shall either be consumed in use or must be disposed of properly in accordance with local environmental regulations. Check with the Environmental Flight for disposal options.

a. An option for the diluted mix is to capture the mix in another tank and use this mix as the diluent water for the deicing equipment provided the fluid/water ratio is less than 05/95. Continue to add water until the low mix ratio is achieved.

b. This option may require procurement of an additional tank (smaller than the bulk storage tank) for use as interim storage. Before any use, the water mix shall be visually checked for contamination, and refractometer checked to ensure the refractometer point is near that of water 00/100. Make the decision for this option based on the economics for tank procurement costs, tank maintenance costs, fluid costs, and disposal costs.

3.12.2 MIL-A-8243, Type II. Unused diluted mix of deicing fluid, once prepared for application, shall not be returned into bulk storage tanks which contain specification grade MIL-A-8243, Type II product. All diluted mix shall either be consumed in use or must be disposed of properly in accordance with local environmental regulations. Check with the Environmental Flight for disposal options.

3.12.3 AMS 1424, Type I. Unused diluted mix of Type I deicing fluid, once prepared for application, shall not be returned into bulk storage tanks which contain AMS 1424, Type I product. All diluted mix shall either be consumed in use or must be disposed of properly in accordance with local environmental regulations. Check with the Environmental Flight for disposal options.

a. An option for the diluted mix is to capture the mix in another tank and use this mix as the diluted water for the deicing equipment provided the fluid/water ratio is less than 05/95. Continue to add water until the low mix ratio is achieved.

b. This option may require procurement of an additional tank (smaller than the bulk storage tank) for use as interim storage. Before any use, the water mix shall be visually checked for contamination, and refractometer checked to ensure the refractometer point is near that of water 00/100. Make the decision for this option based on the economics for tank procurement costs, tank maintenance costs, fluid costs, and disposal costs.

3.13 UNUSED DEICING FLUID (NOT DILUTED).

3.13.1 MIL-A-8243, Type I. Unused undiluted Type I deicing fluid in the deicing equipment shall remain in the equipment until the end of the winter season. Upon completion of the winter season, visually check the fluid for contamination and confirm the refractometer point is within limits for a 100% fluid. The fluid can then be returned to the bulk storage tanks which contain specification grade MIL-A-8243, Type I product.

3.13.2 MIL-A-8243, Type II. Unused undiluted Type II deicing fluid in the deicing equipment shall remain in the equipment until the end of the winter season. Upon completion of the winter season, visually check the fluid for contamination and confirm the refractometer point is within limits for a 100% fluid. The fluid can then be returned to the bulk storage tanks which contain specification grade MIL-A-8243, Type II product.

3.13.3 AMS 1424, Type I. Unused undiluted Type I deicing fluid in the truck shall remain in the truck until the end of the winter season. Upon completion of the winter season, visually check the fluid for contamination and confirm the refractometer point is within limits for a 100% fluid. The fluid can then be returned to the bulk storage tanks which contain AMS 1424, Type I product.

3.14 UNUSED ANTI-ICING FLUID.

3.14.1 AMS 1428, Type II/IV. Unused fluid shall remain in the deicing equipment and not be returned to bulk storage tanks. The more transfer that occurs with this fluid, the more potential for mechanical damage. At the end of the deicing season, remaining Type II/IV fluid in the equipment is too expensive to send to disposal. One potential option is to allow the fluid to remain in the deicing equipment during the summer season. Contact the deicing equipment Single Manager for approval or additional instructions.

a. If utilization of the deicing equipment as a summertime storage tank is not desired or permitted, consider the procurement of a small tank (suitable for the Type II/IV fluid) and storing the fluid in this tank during the summer.

b. In either situation, test the fluid in the fall prior to the beginning of the winter deicing season as previously discussed.

c. This option may require procurement of an additional tank (smaller than the bulk storage tank) for use as interim storage. Make the decision for this option based on the economics for tank procurement costs, tank maintenance costs, fluid costs, and disposal costs.

CHAPTER 4
AIRCRAFT DEICING NON-FLUID ALTERNATIVES

4.1 GENERAL.

When at all possible, employ the maximum use of these techniques. The Air Force is committed to being a good steward of the environment and use of these techniques will enable this effort.

4.2 ALTERNATIVE DEICING TECHNIQUES.

WARNING

Heated water deicing is not authorized because of the potential for refreezing of aircraft components.

4.2.1 Heated Water Deicing. Heated water deicing without a deicing fluid in the mixture shall never be a deicing option. The chance of entrapping water and subsequent refreezing is more risk than can be effectively managed.

4.2.2 Hot Air Blast System (HABS). Use of the hot air blaster with the MA-1A turbine compressor (forced air system) is an effective method of snow removal. There are numerous Warnings and Cautions associated with the use of this equipment, but training and knowledge of proper procedures will ensure a safe and successful operation. This system is especially effective on dry and powdery snow. The following information on the HABS is general in nature and does not take precedence over guidance in either T.O. 35E17-12-1 or aircraft specific technical orders.

WARNING

- Failure to follow defined procedures defined in T.O. 35E17-12-1 can result in either serious personal injury or death. Plumbing temperatures may reach 350°F.
- Blowing snow caused by the HABS can severely reduce visibility for the driver and basket operator. Constant radio contact between the truck driver and basket operator is imperative for a safe operation.
- Double ear protection is required when operating the MA-1A turbine compressor.

a. It is important that the instructions on the operation of the HABS in T.O. 35E17-12-1 be studied and reviewed before operating the system. Hot air blast plumbing is hot during and after operation. Plumbing temperatures may reach 350°F. Blowing snow and a high noise factor can create unusual hazards not normally associated with deicing operations.

WARNING

Not moving the nozzle in a sweeping motion and allowing the air to concentrate in 1 area can result in melting the snow. This can lead to the formation of ice in areas difficult to detect.

CAUTION

When operating parallel to the fuselage and behind the wing, pay particular attention to the position of the top of the MA-1A when the rotator is moved to the right or when turning the truck.

b. Typically, the approach to the aircraft with the deicer truck is with the driver's side. Multiple truck operation and aircraft operations (loading, maintenance, etc.) may dictate an approach from the passenger's side. This can be safely accomplished provided there is constant radio contact between the driver and basket operator. Use the telescoping boom to position the basket and swivel the nozzle in a sweeping action to remove snow. Large accumulations of wet snow will require the nozzle be positioned close to the wing. Maintain sufficient distance between the basket and aircraft to prevent contact when moving the boom.

c. Actual field experience has shown that positioning the nozzle 3 – 4 feet from the aircraft surface and accomplishing a sweeping motion is the most effective means of snow removal to include some wet snow.

CAUTION

Do not direct any forced air system perpendicular to a surface such as the side of the fuselage. Areas such as the fuselage may not be designed to withstand the impact of such systems. Operation of the hot air blast (or any forced air system) from the rear of any flight control surface can damage components.

Table 4-1. Hot Air Blast Temperatures

Distance from Nozzle Inches	Temperature
36	140°F
48	106°F

d. Table 4-1 shows field test results of the HABS in order to determine operating temperatures at 3 – 4 feet from the aircraft surface. The ambient air temperature at the time of the test was 65°F. The blasted air was directed at a 30° angle to the surface to simulate an aircraft surface. Aircraft Single Managers shall review this table for applicability to their aircraft.

e. If the heat from the system is beginning to melt snow, the system is either too close to the surface or being allowed to concentrate.

f. Never operate the HABS from rear of the wing or horizontal/vertical stabilizer in such a manner to cause damage to the control surfaces from the force of the hot air blast. The desired direction is from the front to the rear of flight control surfaces regardless of wind direction but some circumstances may prevent this from always occurring.

g. There are conditions that may preclude always working from front to rear. With aircraft Single Manager approval and the exercising of caution, the HABS may still be used if specific procedures are developed.

(1) The wing area may be so large (for example: C-5); therefore, making it impossible to cover the entire area from front to rear.

(2) Propellers (for example: C-130) or maintenance stands may not permit complete coverage.

h. Damage to flight control surfaces can occur by using the HABS from the rear. This is due to the force of the blast on surfaces not designed for such force.

i. For snow removal from either the wing or horizontal stabilizer surfaces, always begin the operation at the wing tip and move towards the centerline of the aircraft to prevent excessive loading on the wing tips. This is especially true when removing heavy wet snow.

j. Never direct the HABS on the aircraft windscreen or cabin windows. A sudden change in temperature may cause the glass to break or craze.

k. Some aircraft have composite surfaces or very thin skinned surfaces that could be damaged by the blast from the HABS. This potential shall be evaluated when developing aircraft specific procedures.

WARNING

Using any air source to blow snow can result in snow being blown into cavities or openings and subsequent melting of the snow and the forming of ice in areas difficult to detect.

l. Exercise caution when using any air source to blow snow that is near openings such as engine inlets/exhausts, APU inlets/exhausts, balance bays, etc., where the snow can be trapped and subsequently melt forming ice. Aircraft Single Managers shall work with field activities experienced in using the HABS to develop specific procedures.

4.2.3 Mechanical Removal of Snow.

WARNING

To accomplish these procedures on larger aircraft can require workers to be on the actual surfaces. Due to the nature of the snow being slippery (or a Type II/IV pretreated surface), falling or sliding off the surface can occur. Work with MAJCOM Ground Safety personnel if implementing this procedure.

CAUTION

Mechanical removal of snow from any surface that can be obscured by the snow requires knowledge of potential items that can be damaged.

a. Mechanical methods such as sweeping, brushing, using floor squeegees (rubber), or dragging a rope across the surface have been effectively used to remove snow. If these techniques are used, care shall be taken not to damage the aircraft surface.

b. Crews accomplishing this procedure shall be aware of any unusual configurations on the aircraft such as antennas, wing tip vortexes, static discharge devices, vortex generators, fins, etc., which can be hidden by the snow and then damaged by dragging or brushing actions.

4.2.4 Other Alternatives.

a. Parking of aircraft in hangars or parking aircraft where there is maximum solar exposure.

b. Deployment to southern bases for the historically worst periods of inclement weather.

c. Use of covers for small aircraft.

d. Use of covers for helicopter blades on rotary wing aircraft.

CHAPTER 5
AIRCRAFT DEICING/ANTI-ICING EQUIPMENT

5.1 GENERAL.

Requirements for suitable equipment are described in SAE ARP 1971. Proper use of this equipment will result in an effective deicing/anti-icing program.

5.2 USE OF EQUIPMENT.

5.2.1 MIL-A-8243, Type I/II. Spraying units, NSN 1730-00-140-3510 (small deicer unit), NSN 1730-00-529-8885, NSN 1730-00-665-2196, NSN 1730-00-152-2788, NSN 1730-00-874-9617, or deicing truck NSN 1730-01-135-3021 may be used for deicing most trainer, fighter, cargo, and bomber type aircraft.

5.2.1.1 Large Cargo Aircraft. Large aircraft such as the C-5 may also be serviced with spraying equipment such as NSN 1730-00-168-5959, Servicing Platform, Type A/S32M-13, as detailed in 35D34-6 Series technical manuals.

5.2.2 AMS 1424, Type I. Both current Air Force deicing equipment and the new deicing equipment being procured for the AMS 1428, Type II/IV fluid are suitable for applying this fluid.

5.2.3 AMS 1428, Type II/IV.

CAUTION

AMS 1428, Type II/IV fluid can be severely damaged by improper handling or equipment. There is no visual check to determine damage. Use only designated procedures and equipment.

This material is subject to being damaged by mechanical shear or chemical contamination. Use low shear diaphragm or positive displacement pumps (progressing cavity), avoid centrifugal (although some centrifugal types may be suitable), or reciprocating pumps. If there is any question concerning pump suitability, always contact the fluid supplier.

a. Pumps to avoid are reciprocating or piston types with pressure relief valves or gear pumps.

b. Transfer through lines with at least 2-inch inside diameters. Avoid unnecessary bends or elbows in the piping. Ensure that flexible piping is not pinched thereby reducing the cross-sectional area.

5.2.3.1 New Truck Designation. The new deicing trucks capable of handling the AMS 1428, Type II/IV fluids may have the same model number as the older trucks (not capable of handling AMS 1428, Type II/IV fluids). Ensure the equipment being used is capable of handling the new Type II/IV fluid. Always refer to the appropriate deicing equipment technical order as the final authority for capabilities or limitations.

a. All tanks on the new truck are 304 stainless steel which is nonmagnetic. Older trucks used a magnetic 409 stainless steel.

b. New trucks will have 3 pumps compared to 2 pumps for the older trucks. The difference being the visibly larger diagram pump.

5.2.4 Deicing Equipment Fluid Conversion for AMS 1428, Type II/IV. If there is a change of suppliers for the Type II/IV or a change from Type II or Type IV, the deicing equipment shall be cleaned and checked for all residual fluid. Refer to the appropriate deicing equipment technical order for specific procedures.

5.2.5 Deicing Equipment Maintenance, Type II/IV Fluid System (Revalidation). When any modifications or repairs are made to the Type II/IV fluid application equipment of any deicing equipment, the equipment shall be revalidated to ensure the modification of repair does not shear the fluid. Refer to the appropriate deicing equipment technical order for specific procedures.

5.2.6 Annual Validation of Deicing Equipment for AMS 1428, Type II/IV. On an annual basis prior to the deicing season, obtain two samples from each piece of deicing equipment that applies AMS 1428, Type II/IV fluid. Send the samples to a laboratory for a full analysis and conformation of acceptability as described in Paragraph 3.7. One of the samples will be taken after the fluid has passed through the nozzle. Procedures for collecting the sample are included in the appropriate deicing equipment technical order.

5.2.7 Applicable Spray Equipment Technical Manuals.

a. The 35E17 Series technical manuals should be consulted for the purpose of identifying parts, acquiring parts, and for emergency repair and fabrication of any spraying component.

b. Steam cleaners can be utilized to heat solutions of MIL-A-8243 deicing fluid to approximately 120° ± 10°F (49° ± 5°C). Hot water could also be secured

from the base hot water system and mixed with the deicing fluid to eliminate the need for using the steam cleaner.

5.2.8 Refractometers and Glycol Tester. The refractometers below provide temperature compensated refractive index readings for either ethylene or propylene glycol based deicing fluids. One refractometer can read undiluted AMS 1428, Type II & IV fluids 0 – 50 BRIX. This refractometer is best suited for analyzing fluids in the 100% concentrate (receipt at tank, quality checks of tanks). A different model refractometer is required for BRIX readings above 50, such as the concentrated AMS 1424, Type I fluids. The glycol tester can read either ethylene or propylene glycol, is temperature compensated, and can be used in extreme weather conditions. The glycol tester is best suited for flight line operations. Having two different testers for checking freeze points allows quality checks against each instrument and an emergency back-up if one tester is damaged.

a. Refractometers – use the Misco 10431VP refractometer to obtain the 0 – 50 BRIX reading, convert to refractive index using Table 5-2 and then convert to freeze points using the appropriate appendix for the type of fluid being analyzed. This instrument is temperature compensated. Misco 10433VP refractometer is used for 50 – 90 BRIX. Misco DFR-123 Digital Refractometer may be used for direct reading refractive indices, 0 – 56 BRIX, freeze point, or percent. Fluids readings within ±0.002 units are acceptable.

b. Glycol Tester – use the Misco 7084VP+ glycol tester for direct freeze point reading. Place 1 or 2 drops of fluid on the prism with the cover closed. Point the tester to a light source, look through the eyepiece and read the temperature indicated at the boundary between the light and dark portions of the fields. If the dark/light boundary line in the view finder is fuzzy, open the prism cover and clean the cover with a clean, soft cloth or tissue, and check the fluid again. For a fluid concentration greater that 50/50, most glycol testers are not accurate enough for this operation. The Misco 7084VP+ is accurate to mixtures of 65/35. Fluid reading shall be within ±03°F.

(1) To use the Misco 7084VP+ to check the glycol content of a concentrated fluid or the Misco 10431VP refractometer with AMS 1424, Type I concentrated fluid, accomplish the following procedure.

(2) In a clean container (small), pour equal amounts of fluid and water to obtain a 50/50 mixture. Measure the refractive index for a 50/50 mixture and compare to the fluid in the appropriate appendix.

5.3 EQUIPMENT.

Support equipment that will be used during normal operation and maintenance procedures are listed in Table 5-1.

Table 5-1. Equipment

Equipment	Specification, Part No., CAS No.
Tester, Anti-freeze Solution	Misco 7084VP+ Glycol Tester 1-800-358-1100
Tester, Refractometer, 0 – 50 BRIX	Misco 10431VP Refractometer 1-800-358-1100
Tester, Refractometer, 50 – 90 BRIX	Misco 10433VP Refractometer 1-800-358-1100
Tester, Refractometer, Digital	Misco DFR-123 Refractometer 1-800-358-1100
Spray Outfit – Deicing or Decontaminating Fluid, Specification MIL-S-4907	1730-00-529-8885
Spray Outfit – Deicing or Decontaminating Fluid, MB-3	1730-00-665-2196
Spraying Unit, Cleaning Deicing Decontaminating Fluid, 135-0-100	1730-00-874-9617
Deicing Unit, P/N 60148	1730-00-140-3510
Spraying Unit, P/N PO509	1730-01-180-9561
Spraying Unit, MIL-S-26110	1730-00-152-2788
Servicing Platform, Type A/S32M-13	1730-00-168-5959
Deicing Truck, Type DG-A	1730-01-135-3021

Table 5-2. 0 – 50 BRIX Scale – Automatically Temperature Compensated

MISCO Model 10431VP Handheld Refractometer BRIX % to Refractive Index @ 68°F/20°C										
BRIX	**0.00**	**0.25**	**0.50**	**0.75**		**BRIX**	**0.00**	**0.25**	**0.50**	**0.75**
0	1.3330	1.3334	1.3357	1.3341		26	1.3741	1.3745	1.3749	1.3754
1	1.3344	1.3348	1.3351	1.3355		27	1.3758	1.3763	1.3767	1.3772
2	1.3359	1.3363	1.3366	1.3370		28	1.3776	1.3780	1.3785	1.3789
3	1.3373	1.3377	1.3381	1.3384		29	1.3794	1.3798	1.3803	1.3807
4	1.3388	1.3392	1.3395	1.3399		30	1.3812	1.3816	1.3821	1.3825
5	1.3403	1.3407	1.3410	1.3414		31	1.3830	1.3834	1.3839	1.3843
6	1.3418	1.3421	1.3425	1.3429		32	1.3848	1.3852	1.3857	1.3862
7	1.3433	1.3437	1.3440	1.3444		33	1.3866	1.3871	1.3875	1.3880
8	1.3448	1.3452	1.3455	1.3459		34	1.3885	1.3889	1.3894	1.3899
9	1.3463	1.3467	1.3471	1.3475		35	1.3903	1.3908	1.3913	1.3917
10	1.3478	1.3482	1.3486	1.3490		36	1.3922	1.3927	1.3931	1.3936
11	1.3494	1.3498	1.3502	1.3506		37	1.3941	1.3946	1.3950	1.3955
12	1.3509	1.3513	1.3517	1.3521		38	1.3960	1.3965	1.3970	1.3974
13	1.3525	1.3529	1.3533	1.3537		39	1.3979	1.3984	1.3989	1.3994
14	1.3541	1.3545	1.3549	1.3553		40	1.3999	1.4004	1.4008	1.4013
15	1.3557	1.3561	1.3565	1.3569		41	1.4018	1.4023	1.4028	1.4033
16	1.3573	1.3577	1.3581	1.3585		42	1.4038	1.4043	1.4048	1.4053
17	1.3589	1.3593	1.3597	1.3602		43	1.4058	1.4063	1.4068	1.4073
18	1.3605	1.3610	1.3614	1.3618		44	1.4078	1.4083	1.4088	1.4093
19	1.3622	1.3626	1.3630	1.3634		45	1.4098	1.4103	1.4108	1.4113
20	1.3638	1.3643	1.3647	1.3651		46	1.4118	1.4123	1.4128	1.4133
21	1.3655	1.3660	1.3664	1.3668		47	1.4139	1.4144	1.4149	1.4154
22	1.3672	1.3676	1.3680	1.3685		48	1.4159	1.4164	1.4170	1.4175
23	1.3689	1.3693	1.3698	1.3702		49	1.4180	1.4185	1.4190	1.4196
24	1.3706	1.3711	1.3715	1.3719		50	1.4201			
25	1.3723	1.3728	1.3732	1.3736						

How to use the Table:

1. First obtain a sample of the fluid. Use the Misco Refractometer to obtain the 0 – 50 reading on the fluid.
   Ex: for OCTAFLO, we get a reading of 32.25.
2. Go to the table and look for the BRIX reading of 32.25. The refractive index is 1.3852.
3. Since we know the type of fluid being analyzed, we go to the appropriate appendix.
   Ex: for OCTAFLO, we go to APPENDIX B and look up the refractive index of 1.3852.
   Our % volume is approximately 50/50.

CHAPTER 6
AIRCRAFT DEICING/ANTI-ICING FLUID PROCEDURES

6.1 GENERAL.

Use of fluids is the last option that should be considered. Once the decision to use fluids has been made, attempt to minimize their discharge to the waters of the U.S. by the use of BMPs listed in the SWPPP. Any captured and contained fluids shall be disposed of in accordance with local environmental regulations.

6.2 FLUID DEICING/ANTI-ICING PROCEDURES.

6.2.1 One-Step Deicing Procedure.

NOTE

The one-step deicing procedure can be equated to WASHING YOUR CAR.

Shall be accomplished when visible precipitation is not present or not predicted to occur within the time the aircraft is scheduled to depart.

a. For purpose of deicing, use an application of a water diluted and heated fluid (MIL-A-8243, Type I/II, AMS 1424, Type I). Selection of the correct fluid mixture is based on either OAT or AST whichever is lower. The fluid ratio is the same for premix and propmix.

(1) Do not select fluid mixture based on the freezing points of the fluid.

(2) Do not select a mixture lower than either the LOUT (AMS fluids) or ELOUT (MIL-A-8243 fluids).

b. MIL-A-8243, Type I/II and AMS 1424, Type I are effective deicers.

c. There is no anti-icing benefit in using the MIL-A-8243, Type I/II fluids.

d. There is limited anti-icing benefit in using AMS 1424, Type I.

6.2.2 Two-Step Anti-Icing Procedure.

NOTE

The two-step anti-icing procedure can be equated to WASHING YOUR CAR [Step 1] AND THEN APPLYING WAX TO YOUR CAR [Step 2].

Shall be accomplished when visible precipitation is present or predicted to occur within the time the aircraft is scheduled to depart. It involves the combination of both deicing (Step 1) and anti-icing (Step 2).

a. For deicing purposes, use an application of a water diluted and heated fluid (MIL-A-8243, Type I/II, AMS 1424, Type I).

SAE permits deicing with hot diluted AMS 1428, Type II/IV fluids. Due to the higher costs, the Air Force position is to not use these fluids for Step 1 deicing except in extreme cases. It is possible that aircraft in International Airports will be deiced with AMS 1428, Type II/IV fluids.

b. For anti-icing purposes, use an application of a non-diluted and cold fluid (AMS 1428, Type II/IV).

c. Until residual stocks of MIL-A-8243, Type I and Type II at an installation are depleted, the combination of the MIL-A-8243, Type I or Type II as the Step 1 (deicer) and the AMS 1428, Type II/IV as the Step 2 (anti-icer) are permitted only if the fluid supplier of the AMS 1428, Type II/IV agrees.

d. Contact the fluid supplier of the AMS 1428, Type II/IV for approval.

e. Do not continue to purchase the MIL-A-8243, Type I product once the aircraft specific technical orders have included authorization and application procedures for the AMS 1424, Type I fluid. New procurements for a deicer fluid shall be for AMS 1424, Type I.

6.2.3 One-Step Anti-Icing.

NOTE

The one-step anti-icing can be equated to applying wax to an unwaxed car that just happened to be clean.

With a clean aircraft surface and a forecast for inclement weather (especially frosting conditions), anti-icing fluid can be applied in preparation for forecasted inclement weather.

a. This procedure is most applicable for use at night when frosting conditions are forecasted for the next morning. It will also assist in the future removal of frozen precipitation by either deicing fluids or forced air if the anti-icing fluid is applied in anticipation of a forecasted weather event.

b. If inclement weather is forecasted, applying AMS 1428, Type IV fluid to a clean aircraft will facilitate a future deicing operation and may result in the overall use of less fluid. It will also assist in the future removal of frozen precipitation by either deicing fluids or forced air if the anti-icing is applied in anticipation of a forecasted weather event.

c. Generally, frost will occur when the relative humidity is more than 50%, wind speed is less than 7 knots, temperature is less than 41°F, and the sky cover is less than 3/10 cover.

d. Relative humidity of 91 – 100%, wind speeds of 0 – 4 knots, sky cover of 3/10 or less, and temperatures of 30° – 37°F will result in widespread frost on all horizontal and vertical surfaces.

e. Local conditions can often be different.

f. If precipitation does occur and the holdover time is exceeded (and there is a subsequent need to deice), deicing in preparation for flight will be much simpler.

WARNING

Attempting to take off with aged anti-icing fluid on the surface can result in the fluid not shearing as designed and resulting in unknown aerodynamics when the aircraft is at takeoff speed.

g. If precipitation does not occur and the aircraft does not fly, the anti-icing fluid will typically lose its effectiveness within 18 hours or less (dependent upon weather conditions) from application. If visual indications show loss of effectiveness of the fluid after 18 hours or earlier, do not attempt to fly the aircraft with the fluid. An appropriate mixture of heated water/deicing fluid shall be used for removal. If the aircraft does not fly within the effectiveness period of the fluid, the fluid can be left on the aircraft to assist in the subsequent removal of any frozen precipitation which may occur. Prior to any flight, it shall be removed.

6.2.4 Reapplication of Anti-Icing Fluid.

WARNING

Application of anti-icing fluid to a surface which already has anti-icing fluid can result in unknown aerodynamics when the aircraft is at takeoff speed.

NOTE

Again, as related to your car, you should not apply wax to an already waxed surface, you should always wash your car to remove old wax prior to waxing.

Never apply AMS 1428, Type II/IV fluid as an anti-icing fluid to an aircraft surface that has already been anti-iced. Should it become necessary to re-accomplish the anti-icing (weather delays, operational holds, maintenance delays), the aircraft shall first be deiced with a hot deicing fluid mix before the anti-icing application.

6.3 AREAS TO BE DEICED WITH MIL-A-8243, TYPE I/II OR AMS 1424, TYPE I (GENERAL).

CAUTION

Prior to application of deicing or anti-icing fluid to any aircraft, the user of this T.O. shall comply with Paragraph 6.3.3 and Paragraph 6.6.3 Areas Not to Be Deiced.

6.3.1 Critical Areas to Be Deiced. The Aircraft Single Manager shall identify and develop procedures for deicing critical areas. Deicing can be accomplished with warm (not heated) air in some of these areas, hot deicing fluid is not always the answer. Never use sharp or pointed objects in an attempt to break the ice. Typical critical areas are but are not limited to:

a. Wings, Tail, and Control Surfaces – shall be free of ice, snow, slush, or frost. One exception for light frost exists:

Light frost (up to 1/8 inch thick) caused by supercooled fuel is permitted on the lower wing surface (i.e., below the fuel tank area) if the fuselage and all other control surfaces are free of any icing. If deicing is required on any other aircraft surface, the underwing frost shall also be removed. Requires Aircraft Single Manager approval.

b. Sensors (Pitot Tubes, Static Ports, Airstream Direction Detector Probes, Angle of Attack Sensors, Temperature Probes, Engine Inlet Probes, Vortex Generators, etc.) – clear of ice, snow, slush, frost, and fluid residue if internal heat does not clear them.

c. Air Conditioning Inlets/Exits – shall be free of ice, snow, or frost. Outflow valves clear and unobstructed.

CAUTION

Exercise care in the landing gear area to prevent the washing out of lubricants from exposed bearings and joints.

d. Landing Gear/Wheelwell Area – landing gear doors, latches (up and down), steering cables, alternate extension cables, bungee springs, actuators, and indicating switches. Unobstructed and clear of ice, snow, and frost. Heated deicing fluid may be used for removal on areas approved by the Aircraft Single Manager. Cold anti-icing fluid may be applied locally to prevent additional buildup.

e. Fuel Tank Vents – clear of ice, frost, slush, and snow.

f. Fuselage – clear of ice and snow. Especially critical for areas just forward of rear or tail mounted engines. With Aircraft Single Manager approval, light frost is allowed if letters and paint lines are visible.

g. Engine Inlets – clear of internal ice and snow, fan shall be free to rotate.

h. Emergency Doors/Exits and or Other Related Emergency Items – unobstructed and clear of ice and snow and free to operate.

i. Radome and Area Forward of Flight Deck Windshield – clear of ice, slush, and snow. Avoid potential for frozen precipitation to obscure pilot's vision during takeoff.

j. Auxiliary Power Unit (APU) Inlets – clear of internal ice and snow.

6.3.1.1 Control Settings. The Aircraft Single Manager shall identify and develop procedures for those flight controls (or other components) that have specialized settings or configurations for deicing. For example, some aircraft require the horizontal stabilizer be positioned leading edge full up (full nose down trim) during deicing to prevent fluid entrapment.

6.3.2 Mission Essential Areas/Equipment and Deicing. The Aircraft Single Manager (and the appropriate special mission equipment Single Manager) shall determine the suitability/need of applying deicing fluid to these areas. Example: All-light-level-television covers (doors) may need deicing; an ECM pod may not.

6.3.3 Areas Not to Be Deiced. Typically, the following areas should not receive a direct stream of hot deicing fluid. The Aircraft Single Manager shall review the following areas, analyze any other potential non-deicing areas and make final determinations.

a. Landing Gear Brakes (especially carbon).

b. Wheels.

c. Exhausts.

d. Engine/APU Cores.

e. Thrust Reversers.

f. Orifices (interior surfaces) of Sensors. Other methods of removing ice shall be used if internal heaters do not function.

CAUTION

Fighter type aircraft canopies, transport aircraft flight deck windows, cabin windows, and window seals can be damaged by the direct application of hot deicing fluid.

NOTE

On many transport aircraft flight deck and cabin windows, spraying deicing fluid on the fuselage above the windows and allowing fluid to run down is acceptable.

g. Fighter Type Aircraft Canopies, Transport Aircraft Flight Deck Windows, Cabin Windows.

6.4 DEICING PROCEDURES WITH MIL-A-8243, TYPE I/II OR AMS 1424, TYPE I (RELATED TO TYPE OF PRECIPITATION TO BE REMOVED).

WARNING

It is possible on some aircraft that deicing from the rear to the front of a wing or tail surface can result in water being trapped in balance bays or other cavities. Only with the Aircraft Single Manager approval can deicing be accomplished from the rear to the front.

CAUTION

To prevent aircraft structural damage, direct high-pressure fluid at a glancing angle to the aircraft surface.

Anti-icing and Deicing Defrosting Fluids, MIL-A-8243	1
Deicing/Anti-icing Fluid, Aircraft, AMS 1424, Type I	2

6.4.1 Maximum Deicing Effect. Heated fluids applied close to the surface of the aircraft skin (to minimize heat loss) is the most effective means of deicing.

6.4.2 Removal of Frost or Light Ice. Use a nozzle setting giving a solid cone (coarse) spray. This ensures the largest droplet pattern available, thus retaining the maximum heat in the fluid.

6.4.3 Removal of Ice. Use heated fluid to break the bond. The high thermal conductivity of the skin is utilized and a jet of hot fluid is directed at close range onto one spot until the aircraft surface is just exposed. The metal will then transmit the heat laterally in all directions raising the temperature above the freeze point and result in the breaking of the bond with the aircraft skin. By repeating this procedure a number of times, large areas of ice can be broken. The deposits can then be flushed off with either a low or high flow, depending on the amount of the deposit.

6.4.4 Removal of Snow.

CAUTION

On tail (stabilizer) heavy aircraft with large amounts of snow, remove snow from the tail (stabilizer) before removing snow from wing and fuselage

Always consider either the HABS or mechanical means of removing snow (particularly wet deposits) before proceeding with fluids.

a. Deicing fluid is an extremely inefficient means of wet snow removal.

b. Use nozzle setting sufficient to flush off deposits. This method is dependent upon the depth and type of snow.

c. The heavier the deposits, the heavier the fluid flow required. This is particularly true for wet snow.

d. For light deposits of both wet and dry snow, use the same technique as described for frost removal.

6.5 AIRCRAFT DEICING SEQUENCE.

Divide aircraft into four work areas.

a. Forward Left Fuselage and Left Wing

b. Forward Right Fuselage and Right Wing

c. Aft Left Fuselage and Stabilizer

d. Aft Right Fuselage and Stabilizer

6.5.1 Application. Each Single Manager shall tailor these procedures to their particular aircraft. Consideration shall be given to those flight control cavities which have the potential for fluid entrapment. Procedures shall be developed to either prevent occurrence or ensure adequate inspections are accomplished.

CAUTION

Fighter type aircraft canopies, transport aircraft flight deck windows, cabin windows, and window seals can be damaged by direct application of hot deicing fluid.

a. Wings – start at the leading edge wing tip, sweeping in the aft and inboard direction.

b. Fuselage – start along the top centerline and work downward to wing level. Allow the fluid to flow down including over the windows.

c. Stabilizer – start at the top and work downward to the horizontal stabilizer root and outward to the horizontal stabilizer tip.

d. Radome/Nose – deicing of the radome or nose of the aircraft shall be as specified by the Aircraft Single Manager for elimination of snow or ice accumulations.

e. Engine, APU – deposits of snow should be mechanically removed from engine intakes prior to departure. Frozen deposits that may have bonded to either the lower surface of the intake or fan blades may be removed with hot air or as recommended by the Aircraft Single Manager. If the Aircraft Single Manager permits the use of hot deicing fluid, do not spray into the engine cores. Any APU specific procedures shall be developed by the Aircraft Single Manager.

f. Landing Gear – deicing of the landing gear area of the aircraft shall be specified by the Aircraft Single Manager for elimination of snow or ice accumulations. Keep deicing fluid in this area to a minimum. Do not spray deicing fluid directly on wheels and brakes.

6.5.1.1 Application Pressure. Deicing is most effective when applied in a pattern as described for the type of frozen precipitation being removed and typical pressures of 100 – 200 psi, up to 80 gpm.

6.5.1.2 Application Temperature. Temperature of heated solution will be in the range of 160 – 200°F. Desired application temperature is 180°F.

6.5.2 Subsequent Anti-Icing (Step 2 Anti-Icing).

WARNING

The 3-minute time between deicing and the start of anti-icing is critical to ensuring there is no potential for the reformation of ice.

If anti-icing is required due to freezing precipitation, the anti-icing operation shall occur within 3 minutes. This may require area by area operations (with multiple trucks) especially on larger aircraft (C-5, KC-10, C-17, AWACS, E-4, etc.) which have a considerable amount of surface area to be deiced.

6.5.3 Aircraft Precautions While/After Deicing.

CAUTION

Ensure all drain holes are open to ensure water or deicing mixture can drain and reduce the potential for refreezing

a. Care shall be taken to prevent ice/snow containments on the aircraft surfaces from entering or accumulating in intakes or control surface hinge areas.

b. Remove any accumulation of ice, slush, or snow from the wing trailing edge flap areas. Damage can occur if flaps are raised prior to this area being checked and cleaned as required.

c. During heavy or extended precipitation, check for accumulation in cavities such as slots, balance bays, or wing and stabilizer rear spar areas. Use a source of unheated air to blow-dry snow out of these areas. Use a spray solution of deicing fluid to remove slush or ice.

d. Under freezing fog or other similar precipitation conditions, it may be necessary for the front and rear side of engine fan blades to be checked for ice buildup prior to starting the engine. Any deposits found shall be removed as recommended by the Aircraft Single Manager.

6.6 AREAS TO BE ANTI-ICING WITH AMS 1428, TYPE II/IV (GENERAL).

6.6.1 Critical Areas to Be Anti-Iced. The Aircraft Single Manager shall identify and develop procedures for anti-icing critical areas. Typical critical areas are but are not limited to:

a. Wing Upper Surface and Leading Edges

b. Horizontal Stabilizer and Elevator Upper Surfaces

c. Vertical Stabilizer and Rudder

d. Fuselage Upper Surfaces on Center Engine Aircraft (KC-10) – depending on amount and type of precipitation

6.6.1.1 Additional Areas. Aircraft Single Managers may determine there exist other areas on the aircraft which need anti-icing. If so deemed, those areas should be identified.

6.6.2 Mission Essential Areas/Equipment and Anti-Icing. The Aircraft Single Manager (and the appropriate special mission equipment Single Manager) shall determine the suitability/need of applying anti-icing fluid to these areas.

6.6.3 Areas Not to Be Anti-Iced. Typically, the following areas should not receive anti-icing fluid. The Aircraft Single Manager shall review the following areas, analyze any other potential non-deicing areas and make final determinations.

a. Landing Gear Brakes (especially carbon).

b. Wheels.

c. Exhausts.

d. Engine/APU Cores.

e. Thrust Reversers.

f. Orifices of Sensors – heated surfaces that should not ice.

WARNING

Anti-icing fluid applied to any area forward of the flight deck window or canopy will shear during takeoff roll and may obstruct the pilot's vision.

g. Radome (upper surfaces) if the anti-icing fluid could blow back on the flight deck windows or canopy.

h. Flight Deck Windows, Cabin Windows, Canopy, and the Area just Forward of these Windscreens.

6.7 ANTI-ICING PROCEDURES WITH AMS 1428, TYPE II/IV.

WARNING

- Surfaces shall be sprayed symmetrically. Whatever is done to one side, the identical process shall be done to the other side. Flight performance and safety can be compromised if this does not occur.
- The 3-minute time between deicing and the start of anti-icing is critical to ensuring there is no potential for the reformation of ice.

Fluid, Aircraft Deicing/Anti-icing, Non-Newtonian (Pseudoplastic), AMS 1428, Types II and IV 3

6.7.1 Aircraft Anti-Icing Sequence. Divide aircraft into four work areas.

a. Left Wing

b. Right Wing

c. Aft Left Fuselage (if required) and Tail

d. Aft Right Fuselage (if required) and Tail

NOTE

The size of wing on some aircraft may require the wing to be divided into more than 1 section for anti-icing. Ensure complete fluid overlapping if this occurs.

6.7.2 Application.

NOTE

The wing and wing leading edge are critical lifting surfaces. Ensure there is complete coverage on these surfaces.

Anti-icing of the wing shall begin at the crown of the wing and allowed to flow both directions. Start at wing tip, sweeping in the aft and inboard direction. Prior to leaving the wing, hit the leading edge with one complete sweep of fluid. If required on the fuselage, spray the required area on the top centerline until the fluid just begins to run downward. On tail horizontal surfaces, ensure the fluid is just beginning to drip off the leading and trailing edges. On the tail vertical surfaces, start at the top and quickly obtain a complete coverage. Prior to leaving the tail, hit the leading edges (horizontal and vertical) with one complete sweep of fluid.

6.7.2.1 Representative Surface. The first application of fluid shall occur in an unheated area that is visible (if possible) to the Aircraft Commander. This area will be known as the Representative Surface.

a. Since the reformation of ice will typically reoccur in the first area to be anti-iced, starting in this area will enable the Aircraft Commander to have a visual indication of the aircraft condition.

b. Although an area not to be anti-iced, windscreen wipers can be a good indication of precipitation buildup.

c. On many low wing large transport type aircraft, the cockpit is too far forward to permit a practical location for anti-icing to be viewed from the cockpit.

6.7.2.2 Representative Surface Location.

NOTE

The representative surface must be capable of being viewed at night under less than desirable conditions. Viewing through a window may reflect light which can provide false indications.

Aircraft Single Managers shall identify a representative surface visible to the aircrew or Aircraft Commander from inside the aircraft. This area shall be anti-iced first. The area selected shall be unheated to prevent false indications.

a. On fighter aircraft, the left wing (select an area just aft of the leading edge) should always be visible from the cockpit to the Aircraft Commander.

b. On transport aircraft, it is unlikely that an area which can be viewed from the cockpit will exist. In this case, identify an overhead escape hatch, specified window(s), an overwing exit door, or a service door that could be identified for removal. The identified area should be on the wing just aft of the leading edge.

6.7.2.3 Aircraft with T-Tails. On aircraft with a T-tail (C-5, C-141, C-17, etc.), the horizontal stabilizer upper surface and leading edge shall be the last surface to be anti-iced. These areas are not visible from inside the aircraft. By applying the anti-icing fluid last, aircrews have some level of confidence the conditions on the horizontal stabilizer are no worse than being experienced on surfaces having been anti-iced first.

6.7.2.4 Additional Representative Surfaces. Aircraft Single Managers shall consider identifying additional representative surface locations within their aircraft. Inside visual checks can be accomplished by the aircrew on exterior surfaces for the reformation of ice as part of their pretakeoff checks. On fighter type aircraft, one representative surface location should be sufficient if the pilot has good visibility of the aircraft upper surfaces.

6.7.2.5 Application Pressure. Anti-icing is most effective when applied in a fan pattern at low to medium velocities (50 – 60 psi, 20 – 25 gpm) for Type II/IV.

6.7.2.6 Application Temperature. Shall always be used cold.

6.7.2.7 Film Thickness. Apply a sufficient amount to completely coat the surfaces and to form a thin film of approximately 1 – 2 mm (1/32 – 1/16 inch) for Type II and of approximately 1 – 3mm (1/16 – 1/8 inch) for Type IV.

6.7.3 Aircraft Precautions While/After Anti-Icing.

WARNING

Anti-icing fluid applied to an area forward of the flight deck window or canopy can shear during takeoff roll and obstruct the pilot's vision.

Ground deicing/anti-icing crews shall examine the area forward of the flight deck windows and/or canopy before departure and remove all traces of the anti-icing fluid. Examine closely those aircraft with wipers to ensure fluid is not trapped in this area.

a. Any standard aircraft window cleaner identified in the aircraft specific technical orders will remove the AMS 1424, Type I and AMS 1428, Type II/IV fluids if they are inadvertently applied.

b. Pay particular attention to windows fitted with wipers. Fluid can be trapped in this area.

6.8 AERODYNAMIC QUIET AREAS.

There can be a buildup of AMS 1428, Type II/IV fluid in locations known as aerodynamic quiet areas. These are areas where the applied fluids have collected but there was no shearing forces present to remove the fluids during flight. Typical quiet areas are balance bays or other cavities in the wing or horizontal stabilizer area where the fluid can collect. These areas shall be identified by aircraft with instructions to periodically clean. As a minimum, these areas shall be inspected and cleaned after the end of each winter season.

6.9 DEICING/ANTI-ICING WITH ENGINES/APU RUNNING.

Standard operating procedures in most commercial aircraft industry is to deice/anti-ice with the engines OFF, but ARP 4737 permits deicing/anti-icing with engines at idle. This procedure is aircraft specific and shall be specifically authorized or disapproved by the Aircraft Single Managers. The operation of APU during deicing/anti-icing is also aircraft specific and shall be specifically authorized or disapproved by the Aircraft Single Managers.

a. When reviewing this operation for acceptance, consider where the physical placement of a deicing truck and how close to the area (anti-icing only) the truck must be due to the low application pressures of the anti-icing material.

b. It is possible on some aircraft that the truck will be positioned directly behind an engine exhaust area in order to get the anti-icing fluid on the horizontal stabilizer.

WARNING

Harmful fumes can be drawn into the cabin if air conditioning pack switches and APU air switches are not closed. Follow aircraft specific procedures.

c. If approved, idle speed shall be maintained and air conditioning pack switches and/or APU air selected OFF, or as recommended.

6.10 PREVENTION OF DEPOSITS (ONE-STEP ANTI-ICING).

As previously discussed in Paragraph 6.2.3, if inclement weather is forecast, applying AMS 1428, Type II/IV fluid to a clean aircraft will facilitate a future deicing operation and may result in the overall use of less fluid. It will also assist in the future removal of frozen precipitation by either deicing fluids or forced air if the anti-icing fluid is applied in anticipation of a forecasted weather event. This procedure shall be evaluated by each installation for applicability.

6.11 AIRCRAFT SPECIFIC TECHNICAL ORDERS/AIRCREW INSTRUCTIONS.

The information contained within this technical order needs to be available to both aircrews and ground crews. The aircrew information may be placed in either the aircraft Dash 1 or in an AFI or MAJCOM supplement to an AFI. For aircrew information, referencing back to this technical order for other than a source document should be minimized. For ground crew information, the typical location of

information would be in the appropriate maintenance Dash 2 series. For other than aircraft specific information for the ground crew, extensive use of this technical order as a reference is encouraged. Exactly how and in what form to present the information is a Single Manager and MAJCOM decision. Aircrews and ground crews should have access to the following information as a minimum:

a. Aircraft Performance Limitations, if Impacted

b. SAE, ISO, AEA Code Interchange Ability/Equivalency

c. Holdover Time to Include the Latest Tables from FAA FSAT

d. Buffer Temperatures, LOUT, ELOUT

e. Definition of Deicing, Anti-icing, One-Step Deicing, Two-Step Anti-icing, One-Step Anti-icing, Reapplication of Anti-icing Fluid

f. MIL-A-8243, Type I/II Fluids – Application/Procedures of MIL-A-8243, Type I/II, (Approval of spraying deicing fluids from the rear of the wing/tail to the front (as applicable). Include diagrams showing the placement of truck(s) for deicing.)

g. AMS 1424, Type I Fluid – Application/Procedures of AMS 1424, Type I deicing fluids, (Approval of spraying deicing fluids from the rear of the wing/tail to the front (as applicable). Include diagrams showing the placement of truck(s) for deicing.)

h. AMS 1428, Type II/IV Fluids – Application/Procedures of AMS 1428, Type II/IV Deicing Fluids, (Include diagrams showing the placement of truck(s) for anti-icing.)

i. Handling of AMS 1428, Type II/IV Fluids

j. Alternative Deicing Techniques – Approval of Removing Frozen Precipitation from the rear of the wing/tail to the front (as applicable), (Include diagrams showing the placement of truck(s) for the HABS. Include diagrams showing the location items which could be damaged by mechanical removal techniques.)

k. Critical Areas to Be Deiced; Mission Essential Areas/Equipment and Deicing; Areas Not to Be Deiced; Aircraft Precautions While/After Deicing – Diagrams/Sketches showing areas not to deice, (aircraft often transit numerous airfields and personnel at those airfields are not always familiar with all types of Air Force aircraft.)

l. Critical Areas to Be Anti-iced; Mission Essential Areas/Equipment and Anti-icing; Areas Not to Be Anti-iced – Diagrams/Sketches showing areas not to anti-ice, (aircraft often transit numerous airfields and personnel at those airfields are not always familiar with all types of Air Force aircraft.)

m. Representative Surfaces

n. Visual Indication for Loss of Fluid Effectiveness

o. Aircrew Codes

p. Cold Weather Preflights/Inspection

q. Aircrew Checklist for Section VII of Dash 1

r. Operations During Freezing Drizzle and Light Freezing Rain

s. Cold Weather Types of Deicing Checks

t. FAA Publications

u. Cold Soaked Aircraft

v. Clear Ice

w. Deicing/Anti-icing with Engines/APU Running

x. Aerodynamic Quiet Areas

y. APPENDIX B

z. APPENDIX C

aa. APPENDIX D

bb. APPENDIX E

6.12 TRAINING.

With the implementation of the SAE fluids, training is even more critical than ever. MAJCOMs shall develop programs for aircrews, operations personnel, and deicing personnel. FAA AC 135-16, Ground Deicing and Anti-icing Training and Checking is what civilian air carriers use as the start point for the development of a training program.

CHAPTER 7
AIRCREW OPERATIONS

7.1 GENERAL.

Operation of aircraft in a cold weather environment is at best, a difficult task. Use of the information and procedures defined in this chapter will assist in that task. The information contained in this chapter is for use by Aircraft Single Managers and the respective MAJCOM staff in developing the aircraft specific Aircrew Operations. None of the information or procedures defined in this chapter can replace good judgement on the part of the aircrew involved with flight in adverse conditions.

7.2 FAA PUBLICATIONS.

The FAA has numerous publications which provide detailed information concerning civilian air carrier deicing/anti-icing requirements. Prior to developing aircraft specific deicing procedures and training programs, a review of these publications would be of benefit. The publications are free and may be obtained by written request.

a. An alternative method to written requests is to access the FAA home page at: [http://www.faa.gov/]. For FAA documents go to [http://www.faa.gov/docs.htm]. Select appropriate document or publication category as needed.

b. The following FAA publications cover deicing and anti-icing:

1. FAA Advisory Circular 20-117, Hazards Following Ground Deicing and Ground Operations in Conditions Conductive to Aircraft Deicing

2. FAA Advisory Circular 120-58, Pilot Guide for Large Aircraft Ground Deicing

3. FAA Advisory Circular 135-17, Pilot Guide for Small Aircraft Ground Deicing

4. FAA Advisory Circular 120-60, Ground Deicing and Anti-Icing Program

5. FAA Advisory Circular 135-16, Ground Deicing and Anti-Icing Training and Checking

6. FAA Flight Standards Information Bulletins for Air Transportation (FSAT) (The bulletins are published annually prior to the start of each winter season and entitled FAA-APPROVED DEICING PROGRAM UPDATES, WINTER [CURRENT SEASON]. In addition to current Holdover Tables, also included is pertinent information concerning related deicing issues such as freezing rain. Access this bulletin at [http://www.faa.gov/avr/afs/fsat/fsatl.htm].)

7.3 AIRCRAFT OPERATIONS.

WARNING

- Holdover time begins when the first AMS 1428, Type II/IV fluid touches the aircraft. Errors in determining this time can result in erroneous information being passed to the flight crew. Times listed in the tables are guidelines. The ultimate responsibility for an aircraft's ability to perform in a safe environment is that of the Aircraft Commander.

- Deicing/anti-icing fluids do not provide any protection from icing once the aircraft is airborne.

7.3.1 Holdover Tables. Each year after the previous winter season, the G-12 Committee meets to discuss problems and corrections that are needed for future Holdover Tables. They will review recent testing, safety problems, and actual past winter experiences as the basis for developing the new tables (if required). Refer to following Paragraph 7.3.1.1, Step a, for the Air Force approved Holdover Tables each year.

7.3.1.1 FSAT. The FAA publications, see Paragraph 7.2 of this technical order for specifics. The FSAT for the FAA-Approved Deicing Program Updates is published annually prior to the start of the winter season. This FSAT contains current Holdover Tables.

a. The Air Force Flight Standards Agency (AFFSA/XOF) will coordinate with the FAA and give the Air Force's approval of the Holdover Tables and any subsequent changes to it once a year. Once the AFFSA/XOF recommends using the FAA Holdover Tables and approves them for incorporating into appropriate aircrew and ground crew documents (e.g., Aircraft specific technical orders, AFI, MAJCOM supplements to the AFI).

The FAA updates will occur more quickly than those found in SAE publications and/or subsequent changes/revisions of this technical order. For this reason AFFSA/XOF will post the approved and/or modification of the FAA published Holdover Charts annually on their website. The approval process happens in the fall of the year and may take more than a month after the FAA Holdover Tables are made available for review. Once the approved tables are posted, their use is authorized for the Air Force and are to be printed for posting in front of this TO as stated on the title page. The current website to obtain the AFFSA/XOF approved Aircraft Anti-icing, Deicing, and Defrosting document for the current year can be found at LRU [https://private.andrews.amc.af.mil/AFFSA/Xo/xof/xof_weather.htm]. After the website opens the current year Holdover Tables should appear for printing and/or download so you can post them in the front of this TO. This website is a secure website so it must be accessed from a military computer. If problems are encountered please try to go to the Andrews AFB home page at [https://private.andrews.amc.af.mil] then select ORGANIZATIONS at the top of the web page. The organizations page appears, scroll down and select AFFSA. When the HQ Air Force Flight Standards page appears click on XO-Operations at the top of the page. The XO-Director of Operations should appear on the left side of the page and then select XOF-Flight Standards Division. Scroll down the Flight Standards Division page and click on the weather link. The different weather programs will appear on the screen, just scroll down until you find the Aircraft Anti-icing, Deicing, and Defrosting link and click on it. The current year Holdover Tables should appear for printing and/or download. If the Holdover Tables can not be accessed using the above directions or websites please contact Andrews Webmaster at [webmaster@andrews.af.mil] DSN: 858-9986/Commercial: (301)981-9986, or E-mail Mr. Vincent Simpson at vincent.simpson@andrews.af.mil DSN: 857-2143/Commercial: (240)857-2143, or write to 1558 Alabama Ave., Suite 13; Andrews AFB, MD 20762.

b. As a general rule, the maximum time available within the Holdover Table applies to light precipitation conditions, and the minimum time available in the Holdover Table applies to moderate precipitation conditions. Specifically, statements in the table state, CAUTION: THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS.

c. Other factors which can shorten the time are high wind velocity, jet blast, and if the fuel temperature is significantly lower than OAT.

d. Holdover time starts from the time when the first anti-icing fluid is applied to the aircraft. Example: Anti-icing is stated at 1100L. At 1102L, the pump develops a problem and anti-icing is stopped. It takes maintenance 30 minutes to clear the problem and the anti-icing is resumed at 1132L. The remainder of aircraft is anti-iced in 20 minutes and is completed at 1152L. The holdover time started at 1100L and all use of Holdover Tables is based on this start time.

e. Aircrew Dash 1s and appropriate maintenance series TOs should reference the requirement to utilize current and approved Holdover Tables. Additionally, this TO and the accompanying Holdover Tables should be available for reference in such locations as Wing Operations Centers, Command Posts, and Base Operations.

7.3.2 Communication with an Anti-Iced Aircraft. FAA publication, AC 120-58, Guide for Large Aircraft Ground Deicing has developed a 4-element code system (A, B, C, D) which allows for standard communication between the deicing ground crew and the flight crew. The entire international deicing community has adopted this procedure. Aircraft transiting a civilian international airport where deicing/anti-icing is accomplished, will be provided this code by the deicing fixed based operator.

7.3.2.1 Element A. Element A specifies the type of anti-icing fluid. The code shall be either Type I, Type II, or Type IV. Do not confuse the Type I or Type II with the fact that MIL-A-8243 also has a Type I/Type II but with NO anti-icing properties.

a. MIL-A-8243 fluid (both Type I and Type II) have zero (0) holdover time and are never used as an anti-icing fluid. The aircrew code shall never be used when the treatment was with MIL-A-8243 fluids with one exception.

b. Exception – MIL-A-8243, Type I can be used as a deicer in a Two-Step anti-icing process with a AMS 1428, Type II/IV anti-icer (if the AMS 1428, Type II/IV suppliers concurs).

7.3.2.2 Element B. Element B specified the percentage of fluid within the fluid/water mixture (for example, 75/25 is 75% fluid and 25% water).

7.3.2.3 Element C. Element C specifies the time of the beginning of the anti-icing step. It is important that all personnel involved with the operation understands that the holdover time is based on the beginning of the anti-icing step. Holdover times are based on this number.

a. Example: The anti-icing procedure started at 1200L, the anti-icing procedure was completed at 1210L, the holdover time from the appropriate table resulted in a time of 20 minutes; the aircraft has 10 minutes to become airborne before the

holdover time has expired and the protection is lost.

b. All times are based on Local (L) time.

7.3.2.4 Element D. Element D specifies date (day, written month, year). The FAA code is based on local time, the date must be consistent.

Refer to Table 7-1 for example of the format.

7.3.2.5 Implementation. The Aircraft Single Manager and all MAJCOMs users of the respective aircraft shall implement this code system. The code system and Holdover Tables shall be available to aircrews, command post/operations, S&ICC and deicing ground crews to ensure complete communication.

7.3.3 Flight Crew Preflight Inspection/Cold Weather Preflight Inspection. Normal walk around preflight inspection conducted by the flight crew but with increase emphasis on cold weather situations. Notes any aircraft surface contamination and directs any required deicing/anti-icing operations. FAA AC 135-16, Ground Deicing and Anti-Icing Training and Checking, has an excellent description of items to be checked.

Table 7-1. Example of Anti-Icing Code

Element A	Element B	Element C	Element D
Type II	100/0	1628L	28 Jan 97
Type IV	100/0	1300L	11 Mar 97

7.3.4 Functional Flight Control Check. Performed by the flight crew immediately after the anti-ice step is complete. An external observer may be required for this check.

7.3.5 Aircrew Checklist for Cold Weather Operations.

a. Section VII (Adverse Weather Operations) of each aircraft specific Dash 1 Technical Order contains a significant amount of information concerning operations in cold weather environments. Information on ground deicing/anti-icing is often scattered throughout the section. Aircraft Single Managers should consider organizing applicable materiel for ground deicing/anti-icing operations into a checklist format. This will enable aircrews to safely and methodically configure the aircraft for deicing and reconfigure the aircraft once deicing is complete. The checklist should include engines running deicing procedures if permitted by aircraft type.

b. Where applicable, the checklist should direct the positioning of flaps, slats, spoilers, and the horizontal stabilizer to prevent fluid from running into balance bays. Outflow valves, cooling inlet valve, air conditioning pack inlets, APU door position, or other aircraft component which could allow fluid to contact corrosion sensitive areas, damage susceptible composites, or electrical components should also be referenced.

7.3.6 Taxi Interval Between Aircraft. AMS 1428, Type II/IV fluids have the potential to be sheared by jet exhaust blast from a preceding aircraft if the taxi interval between the 2 aircraft is not sufficient. Less than standard intervals shall be avoided.

7.3.7 Visual Indications for Loss of Fluid Effectiveness. A fluid has lost its ability to provide anti-icing when it is no longer able to absorb and melt precipitation.

a. Some visual clues that a fluid has lost this ability include loss of gloss. Look for a change from a smooth gel-like appearance to a slushy milky appearance and finally to a snow or crusted surface.

b. Ice or snow accumulation.

c. Buildup of ice crystals in or on the fluid.

d. Surface freezing, or the presence of slush.

e. Aircraft with windshield wipers. The wipers can be an excellent indicator for those aircraft so equipped.

f. The leading edge of the wing closest to the point where the application began will usually fail first.

7.3.8 Operations During Freezing Drizzle and Light Freezing Rain for Both Installation and Aircrew Operations. The severity of ground icing during freezing rain conditions makes it extremely difficult to accurately predict or substantiate holdover times. HOLDOVER TABLES now have columns for freezing drizzle and light freezing rain. MAJCOMs shall ensure installation procedures emphasize post deicing/anti-icing checking procedures during periods of freezing drizzle and during light freezing rain weather conditions. Reference FAA FSAT 96-14.

7.3.8.1 Pretakeoff and Pretakeoff Contamination Checks. Aircrews shall be aware that it may be difficult to detect ice formation during periods of freezing drizzle or light freezing rain.

7.3.8.2 Limited Visibility. Strict adherence to these checks can be critical especially if the checks are accomplished from inside the aircraft, at night, or under limited visibility conditions.

7.4 TYPES OF DEICING CHECKS.

There are three checks that the FAA has mandated and the civilian air carriers will accomplish. The decision on implementation and final wording of any checks implemented is a MAJCOM decision. A description of each check follows in subsequent paragraphs.

7.4.1 Aircraft Deicing/Anti-Icing Procedures.

a. A post application check made following aircraft deicing and anti-icing fluid application and accomplished by qualified ground crews.

b. Check determines if the wings, control surfaces, propellers, engine inlets, and other critical surfaces are free of frost, ice, or snow before taxi. If the aircraft does not have wing clear-ice detectors, touching the aircraft surface is the only known method to date to ensure no ice is present.

c. MAJCOMs shall determine the time prior to takeoff that this check will occur.

7.4.2 Pretakeoff Check. A PRETAKEOFF CHECK is made to check for contamination that may have occurred during the holdover time from the interior of the aircraft, normally from inside the cockpit and other locations as designated.

7.4.3 Pretakeoff Contamination Check.

WARNING

If there is any doubt by the aircrew as to the condition of the aircraft, abort the takeoff and return for a thorough assessment which may require another deicing and anti-icing process.

a. A PRETAKEOFF CONTAMINATION CHECK (or an approved alternative procedure) is required if takeoff is to occur outside of holdover time. This check shall be conducted 5 minutes before takeoff and from outside the aircraft unless the MAJCOM deicing/anti-icing program specifies otherwise.

b. Reliance on representative surfaces is not always satisfactory for determining the aircraft is free of contamination while conducting this check Reference FAA AC 120-60, 9.d.(3).

c. Particularly critical on hard wing aircraft with aft fuselage-mounted, turbine engines. Unless the Aircraft Single Manager can develop a positive means of determining ice is not present, a hands on check known as OUTSIDE-THE-AIRCRAFT CHECK may be required. Aircraft Single Managers and MAJCOMs shall consider this a requirement for all hard wing aircraft if Holdover Table time is exceeded.

7.4.3.1 Outside-The-Aircraft Check. Used in lieu of a PRETAKEOFF CONTAMINATION CHECK if the aircraft does not have approved procedures from inside the aircraft.

a. A check to ensure that the wings and control surfaces are free of frost, ice, and snow. It shall be accomplished within 5 minutes prior to beginning takeoff. It shall be accomplished from outside the aircraft.

b. Usually involves Tactile Check (touching the representative wing and control surfaces) for positive determination of ice indications.

c. Aircraft Single Managers and MAJCOMs shall determine if this is an applicable procedure for their aircraft.

7.4.4 Takeoff Operation Chart. Figure 7-1 on the next page was extracted from FAA AC 120-60. It provides an excellent pictorial display of how the three types of deicing checks fit together: Aircraft Deicing/Anti-Icing Procedures, Pretakeoff Check, and Pretakeoff Contamination Check.

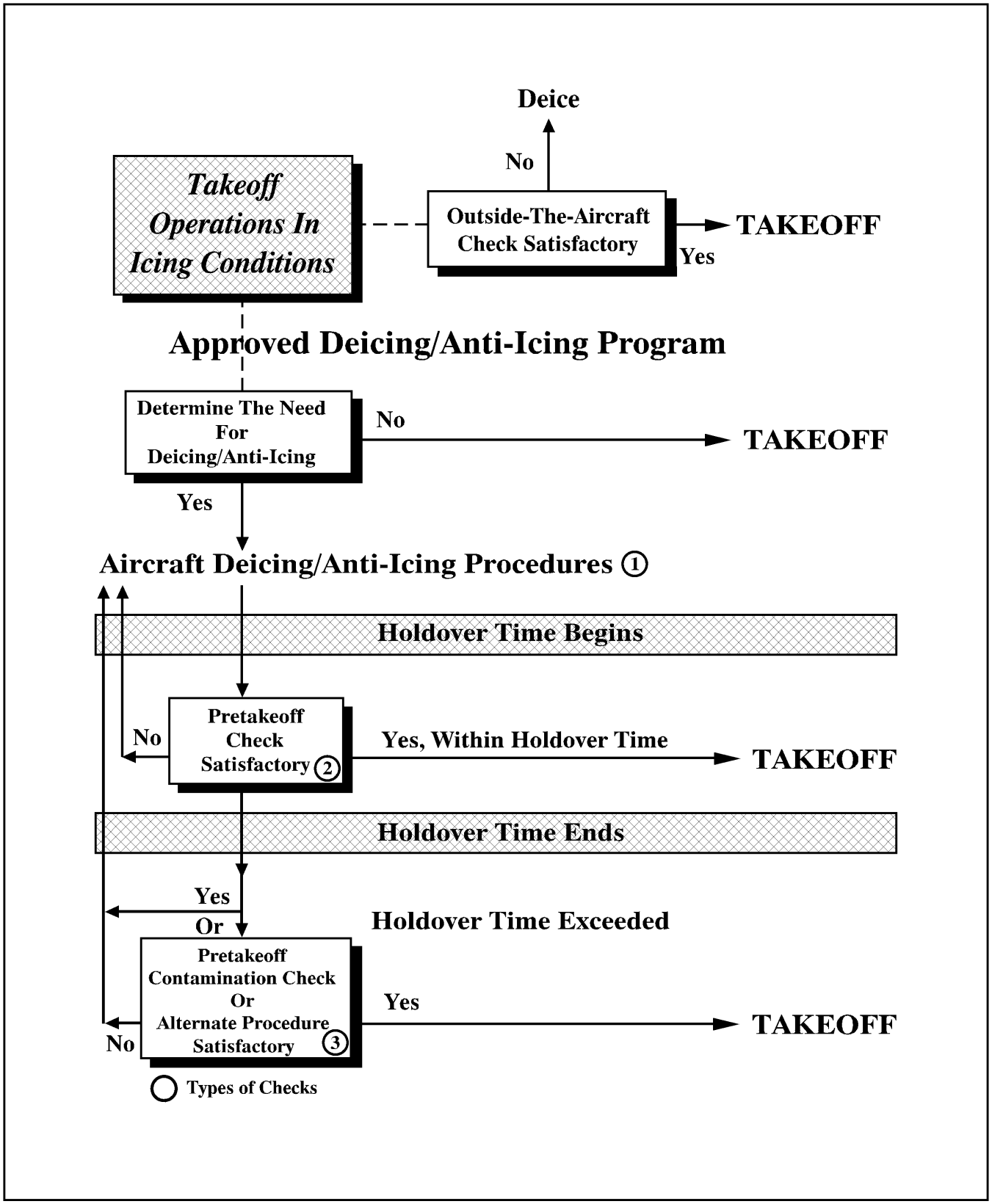

Figure 7-1. Takeoff Operations in Icing Conditions

APPENDIX A
NOT APPLICABLE

A.1 NOT APPLICABLE.

APPENDIX B
AMS 1424, TYPE I

B.1 SCOPE.

B.1.1 Scope. This document contains the mixture ratio, freezing point, refractive index, and LOUT for the fluid suppliers which can be expected to be procured by DLA.

B.1.2 Philosophy. The LOUT includes a Buffer Temperature of +18°F (+10°C). Do not attempt to use at strengths greater than the suppliers respective Eutectic Point. Do not use at temperatures lower than the respective fluid supplier's LOUT. The selection of the appropriate solution strength will be made based on the temperature in the LOUT column, not the freezing point of the solution.

B.1.3 Chemical Reformulation. The AMS 1424 specification does not specify that the fluid will be glycol based, consequently there are several new fluids under development that are glycol free. Although several of these fluids are presently qualified to the AMS 1424 specification they are not approved for Air Force use due to operational problems that were experienced during field tests. These new fluids will be gradually phased in over time after they have been tested for materials compatibility and operational performance.

Table B-1. OCTAFLO EF™

OCTAFLO EF™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
20/80	+21°F/–06°C	1.352	+39°F/+04°C
30/70	+11°F/–11°C	1.364	+29°F/–01°C
40/60	–02°F/–19°C	1.374	+16°F/–09°C
50/50	–19°F/–28°C	1.384	–01°F/–18°C
55/45	–30°F/–34°C	1.389	–12°F/–24°C
60/40	–40°F/–40°C	1.394	–22°F/–30°C
65/35 [2]	–65°F/–54°C	1.398	–27°F/–33°C
100/0	Do Not Use	1.425	N/A [3]
Color: Orange (reddish – always confirm on MSDS)			
Octagon Process – 1-800-423-3375			

[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C).
[2] Eutectic Point – the lowest freezing point possible
[3] N/A – Not Applicable

Table B-2. ARCOPlus™

ACROPlus™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
20/80	+22°F/–06°C	1.352	+40°F/+04°C
30/70	+11°F/–12°C	1.363	+29°F/–02°C
40/60	–03°F/–19°C	1.374	+15°F/–09°C
50/50	–20°F/–29°C	1.384	–02°F/–19°C
55/45	–31°F/–35°C	1.389	–13°F/–25°C
60/40	–43°F/–42°C	1.394	–25°F/–32°C
70/30 [2]	–60°F/–51°C	1.403	–42°F/–41°C
100/0	Do Not Use	1.426	N/A [3]
Color: Orange (reddish – always confirm on MSDS)			
Lyondell Chemical – 1-800-321-7000			

[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C).
[2] Eutectic Point – the lowest freezing point possible
[3] N/A – Not Applicable

Table B-3. SAFETEMP ES™

SAFETEMP ES™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
20/80	+20°F/–07°C	1.353	+38°F/+03°C
30/70	+11°F/–12°C	1.364	+29°F/–02°C
40/60	–02°F/–19°C	1.374	+16°F/–09°C
50/50	–19°F/–28°C	1.384	–01°F/–19°C
55/45	–29°F/–34°C	1.390	–10°F/–24°C
60/40	–40°F/–40°C	1.394	–22°F/–30°C
63/37 [2]	–49°F/–45°C	1.398	–31°F/–35°C
100/0	Do Not Use	1.426	N/A [3]
Color: Orange (reddish – always confirm on MSDS)			
Home Oil Company – 1-800-999-9645			

[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C).
[2] Eutectic Point – the lowest freezing point possible
[3] N/A – Not Applicable

Table B-4. KILFROST DF PLUS (88)™

KILFROST DF PLUS (88)™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
20/80	+20°F/–07°C	1.354	+38°F/+03°C
30/70	+12°F/–11°C	1.364	+30°F/–01°C
40/60	+01°F/–17°C	1.374	+19°F/–07°C
50/50	–14°F/–25°C	1.384	+04°F/–15°C
60/40	–36°F/–38°C	1.394	–18°F/–28°C
68/32 [2]	–72°F/–58°C	1.401	–54°F/–48°C
100/0	Do Not Use	1.423 – 1.426	N/A [3]
Color: Orange (reddish – always confirm on MSDS)			
CRYOTECH – 1-800-346-7237			

[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C)
[2] Eutectic Point – the lowest freezing point possible
[3] N/A – Not Applicable

Table B-5. UCAR PG™ (A Dow Product)

UCAR PG™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
25/75	+17.6°F/–8°C	1.354	+35.6°F/+2°C
30/70	+12.2°F/–11°C	1.364	+30.2°F/–1°C
35/65	+6.8°F/–14°C	1.369	+24.8°F/–4°C
40/60	–0.4°F/–18°C	1.374	+17.6°F/–8°C
45/55	–9.4°F/–23°C	1.379	+8.6°F/–13°C
50/50	–20.2°F/–29°C	1.384	–2.2°F/–19°C
55/45	–33°F/–36°C	1.389	–13°F/–25°C
60/40	–41°F/–44°C	1.393	–29°F/–34°C
65/35	–63°F/–53°C	1.398	–45°F/–43°C
100/0	Do Not Use	1.424	N/A [2]
Color – Orange (reddish – always confirm on MSDS)			
Distributor Ascent Aviation Product 315-625-7299			

[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C)
[2] N/A – Not Applicable

APPENDIX C
AMS 1428, TYPE II

C.1 SCOPE.

C.1.1 Scope. This document contains the mixture ratio, freezing point, refractive index, and LOUT for the 2 fluid suppliers which can be expected to supply DLA.

C.1.2 Philosophy. The LOUT includes a Buffer Temperature of +13°F (+7°C). Always use at strengths of 100/00. Do not use at temperatures lower than the respective fluid supplier's LOUT.

C.1.3 Usage. At the time of this writing AMS 1428, Type II, is no longer in use in the United States. However, the product is still in widespread use in Europe.

Table C-1. KILFROST ABC-3™

KILFROST ABC-3™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
50/50	Do Not Use	1.362	N/A [2]
75/25	Do Not Use	1.377	N/A [2]
100/0	–17°F/–27°C	1.392	–20°F/–29°C
Color: Light Yellow or Clear (always confirm on MSDS)			
KILFROST LTD, England – (0)1434-320332			

[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C).
[2] N/A – Not Applicable

APPENDIX D
AMS 1428, TYPE IV

D.1 SCOPE.

D.1.1 Scope. This document will contain the mixture ratio, freezing point, refractive index, and LOUT for the fluid supplier which can be expected to supply DLA.

D.1.2 Philosophy. The LOUT includes a Buffer Temperature of +13°F (+7°C). Always use at strengths of 100/0. Do not use at temperatures lower than the respective fluid supplier's LOUT.

Table D-1. OCTAGON MAX FLIGHT 04™

OCTAGON MAX FLIGHT 04™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
50/50	Do Not Use	1.361	N/A [2]
75/25	Do Not Use	1.377	N/A [2]
100/0	–33°F/–36°C	1.390 – 1.394	–18°F/–28°C
Color: Emerald Green (always confirm on MSDS)			
Octagon Process – 1-800-423-3375			
[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C) [2] N/A – Not Applicable			

Table D-2. KILFROST ABC-S™

KILFROST ABC-S™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
50/50	Do Not Use	N/A [2]	N/A [2]
75/25	Do Not Use	N/A [2]	N/A [2]
100/0	–35°F/–37°C	1.390 – 1.393	–22°F/–30°C
Color: Emerald Green (always confirm on MSDS)			
CRYOTECH (Authorized Distributor) – 1-800-346-7237			
[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C) [2] N/A – Not Applicable			

Table D-3. SAFEWING MP IV 2001™

SAFEWING MP IV 2001™ % by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	LOUT [1] °F/°C
50/50	Do Not Use	N/A [2]	N/A [2]
75/25	Do Not Use	N/A [2]	N/A [2]
100/0	–31°F/–35°C	1.389 – 1.392	–19°F/–29°C
Color: Emerald Green (always confirm on MSDS)			
Lyondell Chemical – 1-800-321-7000			

[1] EXCEPTION – For any fluid mixture under conditions of freezing drizzle and light freezing rain at temperatures below 27°F (–3°C), the LOUT is limited to 14°F (–10°C).
[2] N/A – Not Applicable

APPENDIX E
MIL-A-8243, TYPE I/II

E.1 SCOPE.

E.1.1 Scope. This document contains the mixture ratio, freezing point, refractive index, and ELOUT for Type I and Type II.

E.1.2 Philosophy. The ELOUT includes a Buffer Temperature of +18°F (+10°C). Do not attempt to use at strengths greater than 70/30. Do not use at temperatures lower than the ELOUT. The selection of the appropriate solution strength will be made based on the temperature in the ELOUT column, not the freezing point of the solution.

Table E-1. MIL-A-8243, Type I (Propylene Glycol)

% by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	ELOUT °F/°C
20/80	+23°F/–05°C	1.354	+°41F/+05°C
30/70	+14°F/–10°C	1.365	+32°F/+00°C
40/60	+01°F/–17°C	1.375	+19°F/–07°C
50/50	–17°F/–27°C	1.385	+01°F/–17°C
55/45	–29°F/–34°C	1.390	–11°F/–24°C
60/40	–40°F/–40°C	1.395	–22°F/–30°C
70/30	–83°F/–64°C	1.404	–65°F/–54°C
100/0	Do Not Use	1.427	N/A [1]
Color: Clear (always confirm on MSDS)			
[1] N/A – Not Applicable			

Table E-2. MIL-A-8243, Type II (3:1 Ratio of Ethylene Glycol : Propylene Glycol)

% by Volume (fluid/water)	Freezing Point, °F/°C of Solution	Refractive Index @ 68°F	ELOUT °F/°C
20/80	+20°F/–07°C	N/A [1]	+38°F/+03°C
30/70	+09°F/–13°C	N/A [1]	+27°F/+03°C
40/60	–05°F/–21°C	N/A [1]	+13°F/–11°C
50/50	–25°F/–32°C	N/A [1]	–07°F/–22°C
55/45	–38°F/–39°C	N/A [1]	–20°F/–29°C
60/40	–49°F/–45°C	N/A [1]	–31°F/–35°C
70/30	–81°F/–63°C	N/A [1]	–63°F/–53°C
100/00	Do Not Use	N/A [1]	N/A [1]
Color: Clear (always confirm on MSDS)			
[1] N/A – Not Applicable			